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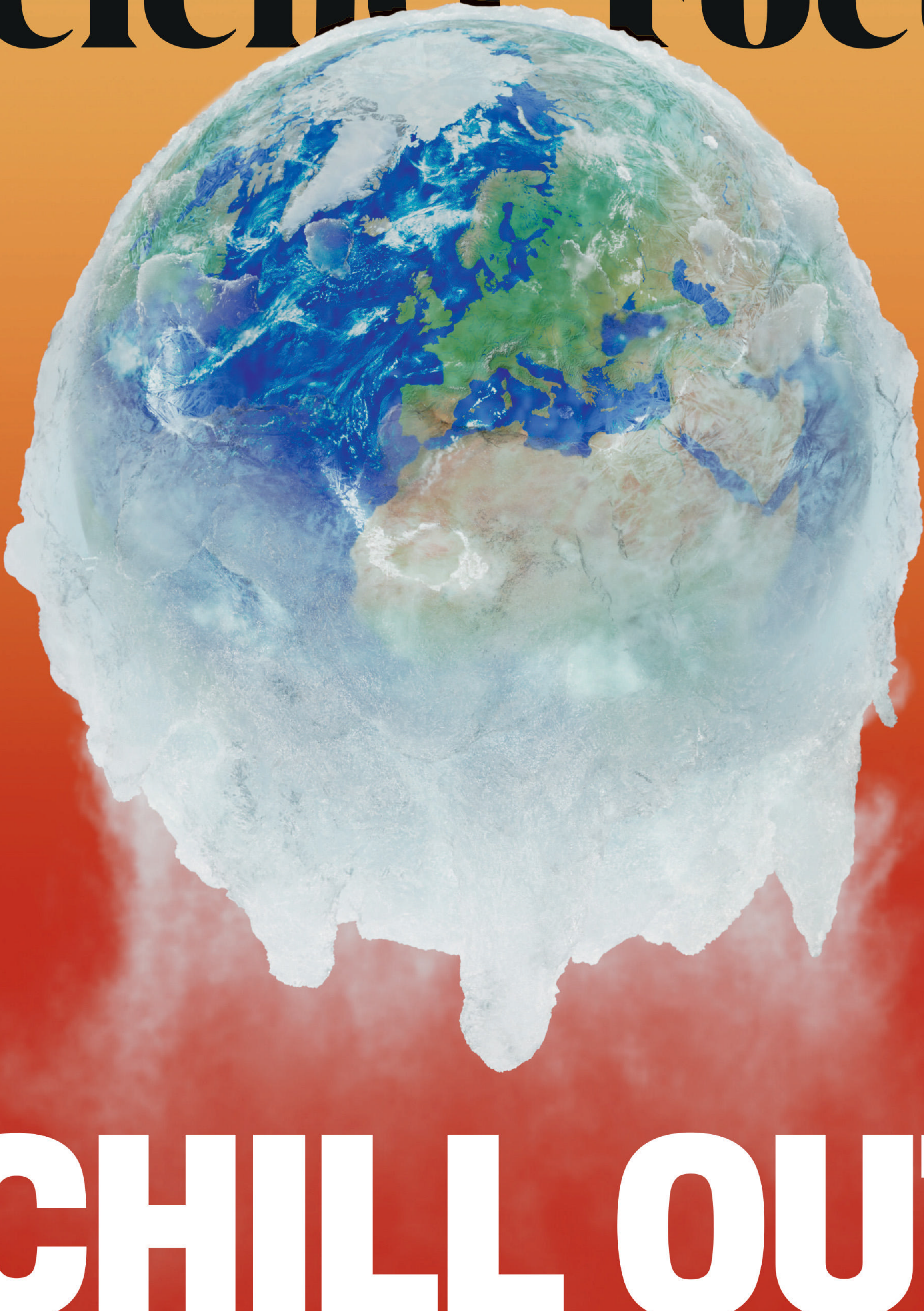
HOW TO BEAT THE POST-LUNCH SLUMP (WITHOUT CAFFEINE)

Science Focus



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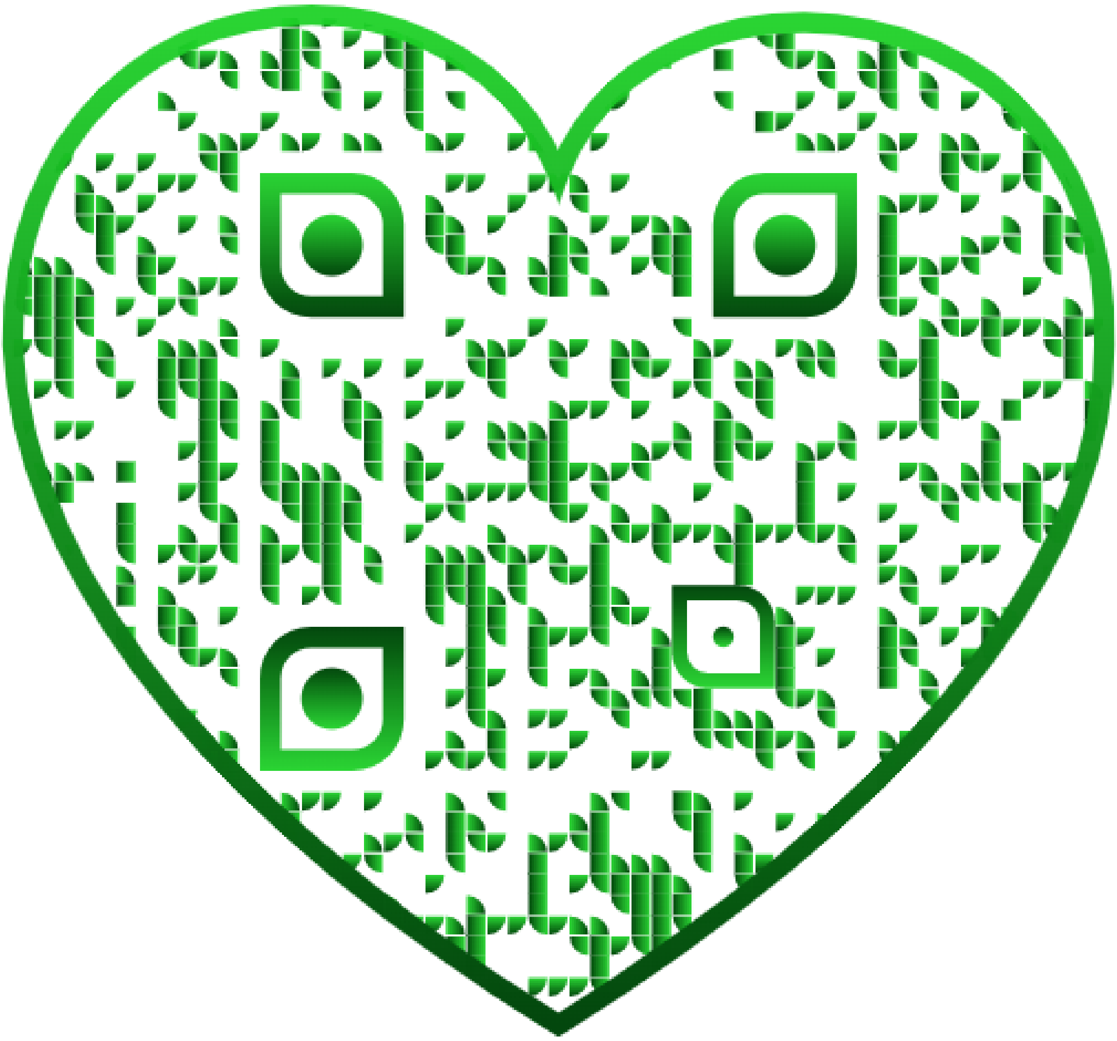
Scientists are preparing previously unthinkable interventions to cool our boiling planet

SILENCE YOUR INTRUSIVE THOUGHTS

MEET THE DOOMSDAY ASTEROID HUNTERS

DOGS VERSUS BABIES: WHO MAKES US HAPPIER?



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FROM THE EDITOR

The last 10 years on Earth have been the hottest since records began. To make matters worse, 2024 was the first calendar year that was, on average, 1.5°C warmer than the pre-industrial era.

This will come as no surprise to anyone who follows the news. Summer is now synonymous with heatwave warnings, droughts and wildfires. But the numbers were confirmed at the start of the year in a report published by the World Meteorological Organization – a ringing alarm for those who can influence society's carbon emissions.

There were smidgens of hope in the report. One of the factors at play was El Niño, an enormous weather pattern that was particularly active over the last two years, functioning like bellows to a scorching planet. Plus, CO_2 emissions, despite reaching a record level in 2024, have plateaued over the last decade. Though that modest achievement, most analysts would agree, won't be enough. The carbon needle needs to move the other way, and fast.

"[This] does not mean the long-term goal is shot," said UN Secretary-General António Guterres, reacting to the report. "It means we need to fight even harder to get on track. Blazing temperatures in 2024 require trail-blazing climate action in 2025." Exactly what form that trail-blazing action could take is one of the questions being asked by ARIA, the UK's Advanced Research and Invention Agency. Turn to p62 to explore the ambitious projects aiming to cool the planet.

Daniel Bennett

Daniel Bennett, Editor

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ON THE BBC THIS MONTH...

Powering Our Robot Overlords
With Google's greenhouse gas emissions increasing by nearly 50 per cent in the last five years, this episode of *Rare Earth* asks if there might be a more efficient way to deal with our data.
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Shipping Containers Fixing the World
The *People Fixing the World* series continues with a look at the unlimited possibilities for repurposing shipping containers, from converting them into classrooms to turning them into carbon capture storage devices.
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Springwatch: 2025 Extra
Some of the best moments from this year's *Springwatch* are collected together in these voiceover-free 15-minute snippets, so you can enjoy nature in a more mindful manner.
Watch now on BBC iPlayer

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Reporter Ana looks into the health problems people could face in the US states working to remove fluoride from drinking water. →p31

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Scientists are preparing previously unthinkable interventions to cool our boiling planet

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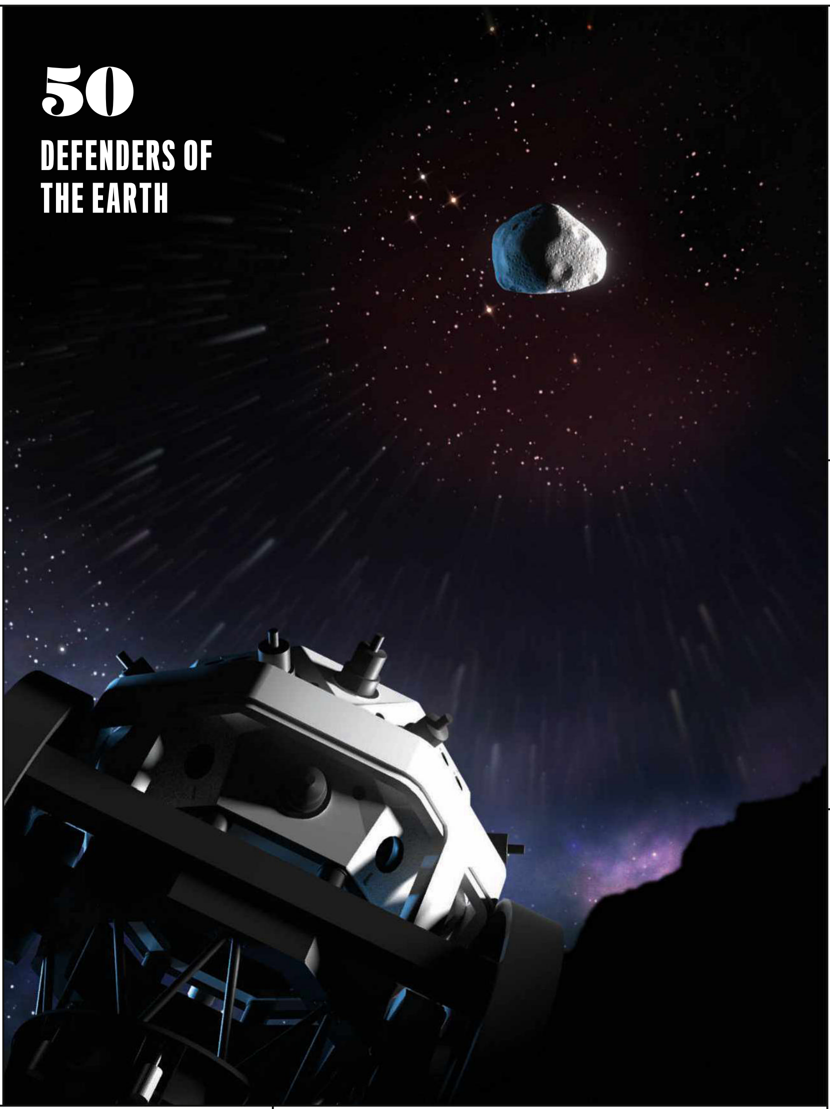

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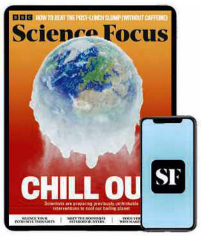

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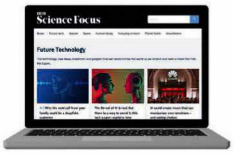

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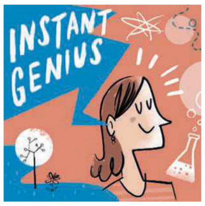

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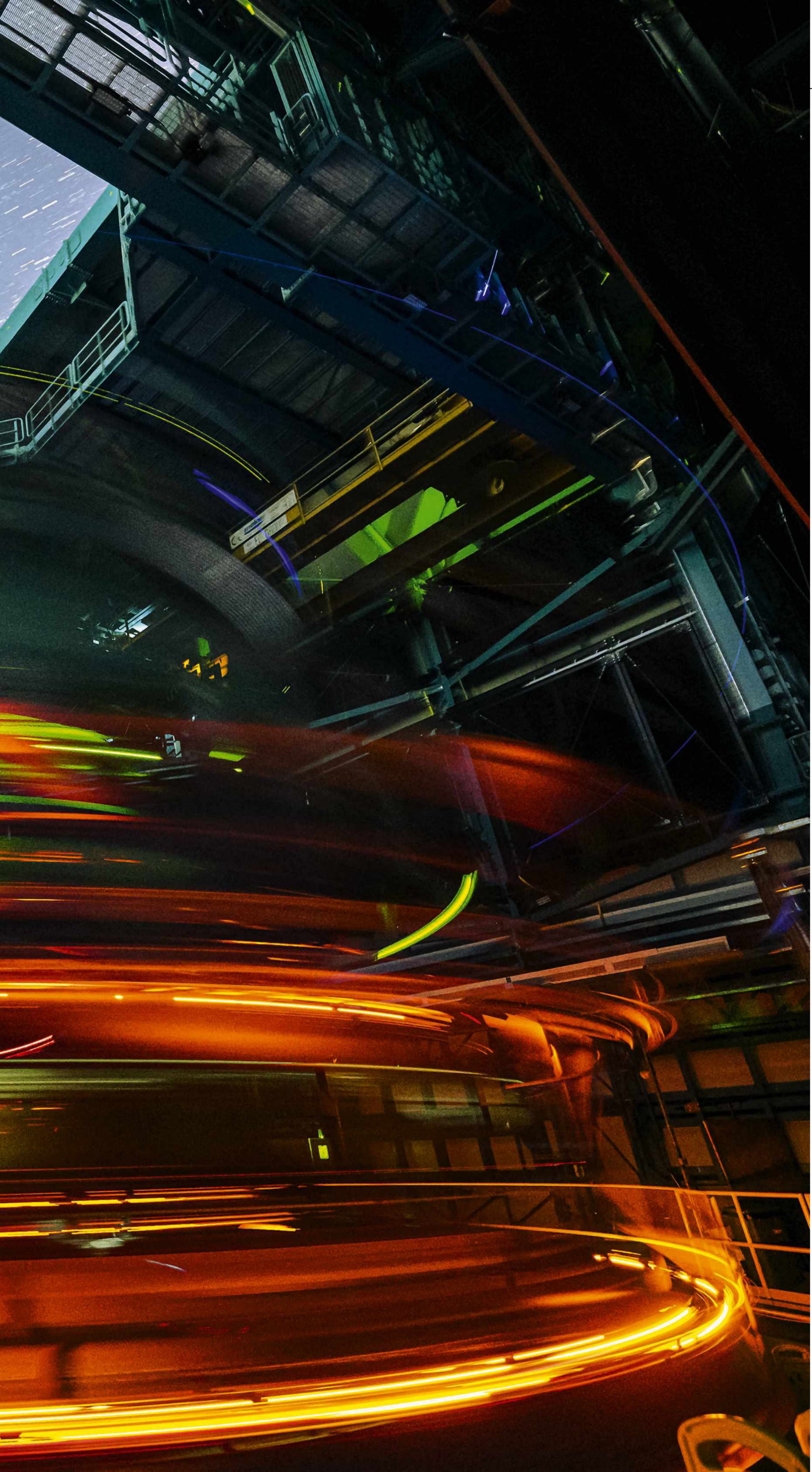

EYE OPENER

Spinning top

CERRO PACHÓN RIDGE, **CHILE**

It might look like a fairground attraction, but this whirlwind of lights is actually one of the most advanced telescopes in the world. The Simonyi Survey Telescope (captured here in a long-exposure photo while being tested in June) is housed at the Vera C Rubin Observatory on a mountaintop in Chile and has been built to film a movie of the stars.

The telescope will spend the next 10 years rapidly and repeatedly surveying the entire southern hemisphere sky, while taking thousands of pictures every night using the world's biggest digital camera. By doing so, it'll effectively produce a motion picture of a big part of the visible Universe, allowing us to see the tiniest changes in distant astronomical objects.

It's a project that'll produce a gargantuan amount of data – 20 terabytes a night. As such, artificial intelligence has been introduced to help astronomers sift through it all and determine where best to point the scope next. Tracking changes in the objects will provide clues regarding the presence of dark matter and the effects of dark energy. Needless to say, the prospect of unravelling those two mysteries has astronomers everywhere in a spin.

HERNAN STOCKEBRAND /RUBINOBS/NSF

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EYE OPENER

It's behind you!

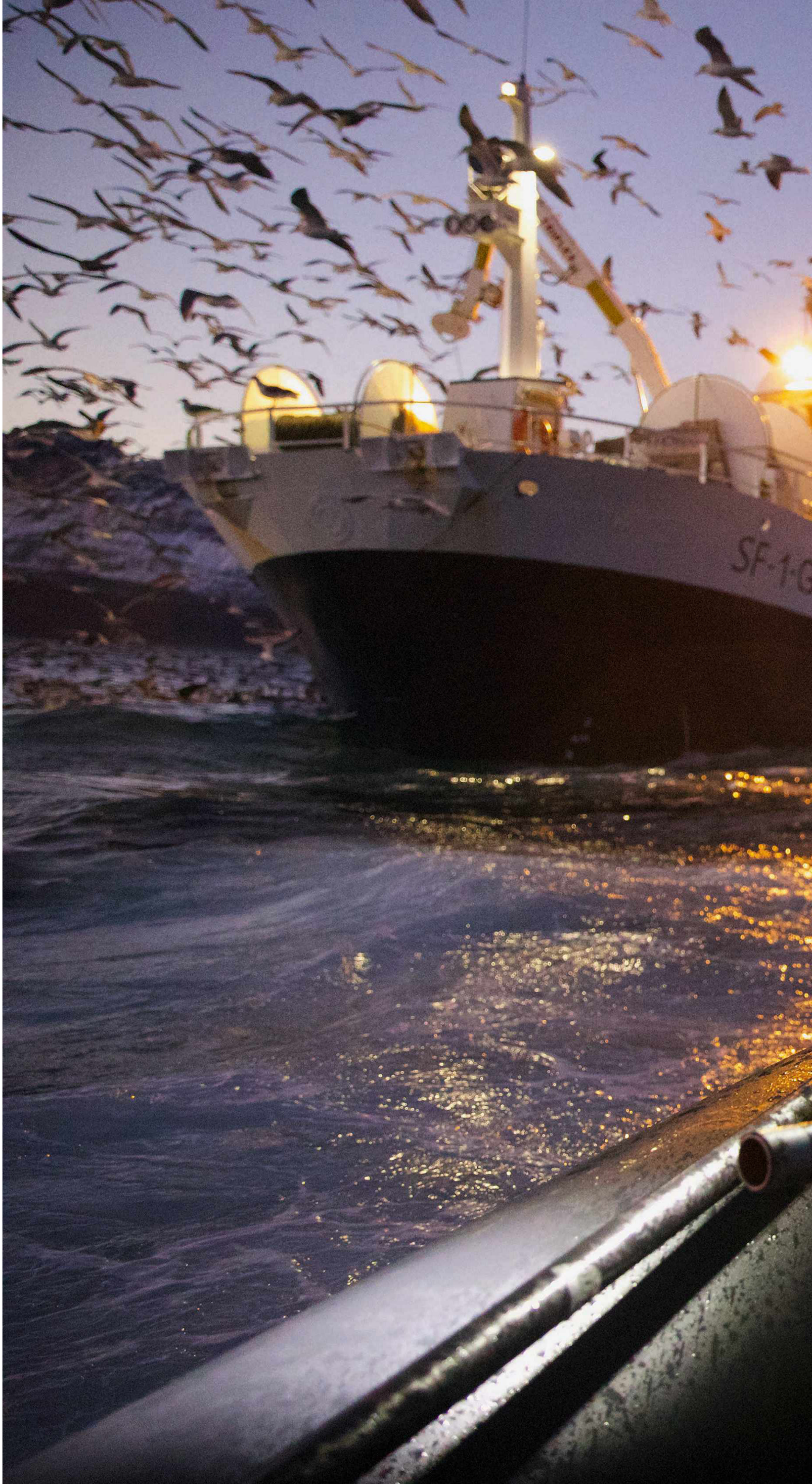
KVÆNANGEN, TROMS, **NORWAY**

Audun Rikardsen is on the hunt for whales. Don't worry, though, his intention isn't to kill them. He and his crewmate Emma Vogel (behind the camera) are looking to tag the massive sea mammals, so their movements can be tracked and their behaviour better understood.

Rikardsen is a biologist and has taken to the fjords of northern Norway, along with Vogel (an animal movement researcher, ecologist and photographer) to investigate the health and habits of the whale pods that pass through the region.

Like the gulls that fill the sky in this shot, the pair trails the fishing vessels that draw in huge schools of herring. The presence of the fish brings the birds, but also draws the whales – usually orcas (*Orcinus orca*) and humpbacks (*Megaptera novaeangliae*) – to the surface. And when one appears, Rikardsen raises the air rifle from his lap, targets the cetacean and pulls the trigger in the hopes of hitting it with a tag. The tag then transmits data such as when and where the whale dives, and the depths it reaches when it does.

It may be a scientific endeavour, but there's still an element of luck involved. Look over Rikardsen's left shoulder and you can see one that got away.



EMMA VOGEL

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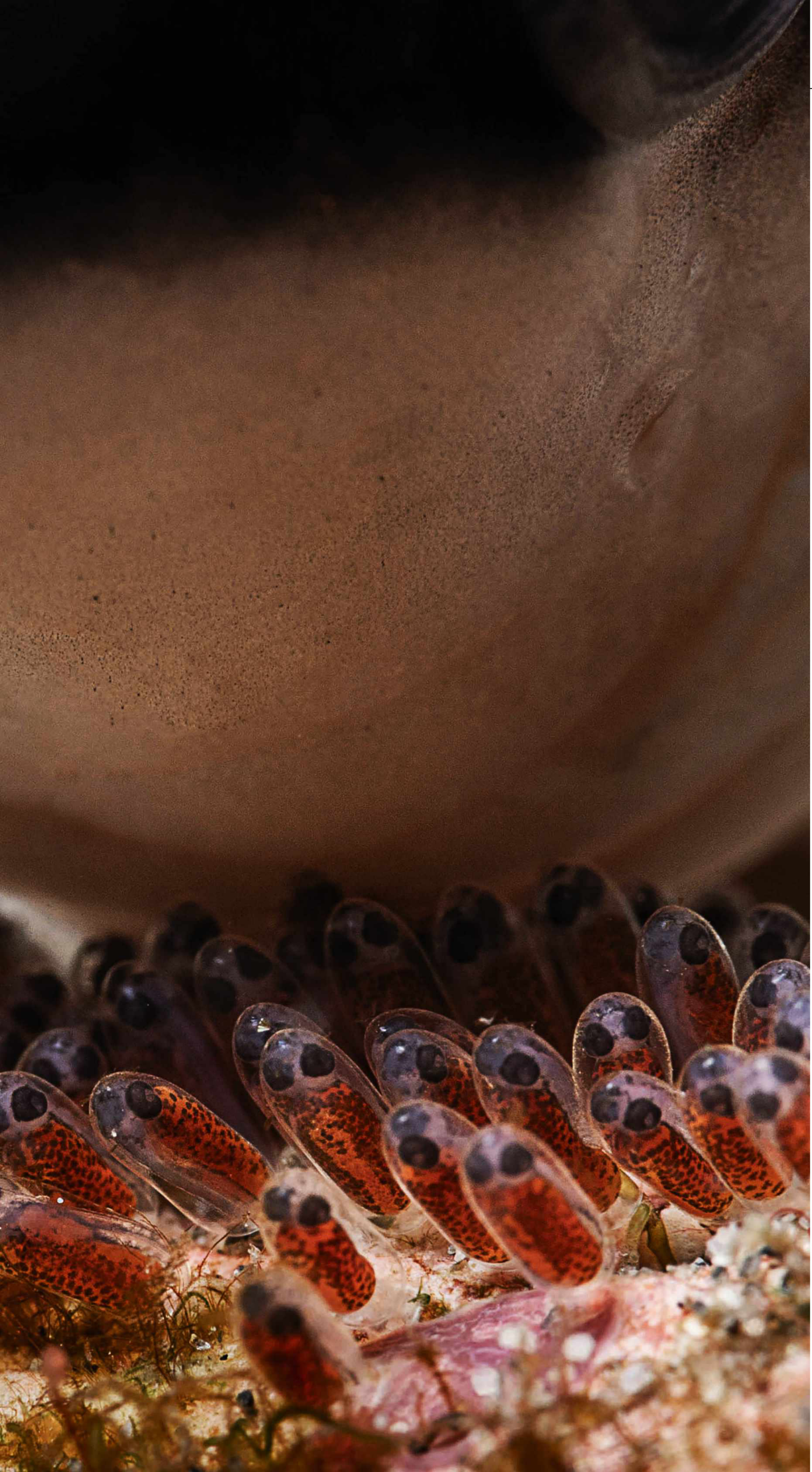

EYE OPENER

Fathering Nemo

PADANGBAI, **BALI**

Though the signature orange and white stripes are cropped out, this photograph captures the minute details of a clownfish (*amphiprioninae*) tending to the eggs of its future children.

More accurately, it captures a father looking after his sons. That's because clownfish are protandrous hermaphrodites, meaning that they're all born and mature as males, but when the time comes to breed, one fish (usually the biggest of the group) will transform to become a female. The change takes place over the course of six months.

After laying a clutch of up to 1,000 eggs in their chosen anemone nest, a female clownfish has nothing to do with the hatching process. It's up to the smaller male to look after them. He cleans the eggs by fanning them with his pectoral fins and aggressively chases away any circling predators.

He also performs the difficult task of picking out the dead or infertile eggs from the clutch, which he does by eating them. This may sound brutal, but removing the unviable eggs gives the rest of his future children the best chance of surviving the six-to-seven-day egg stage of their lives, before they hatch into healthy larvae.

FRANÇOIS BAELEN/OCEAN IMAGE BANK

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FEEDBACK

YOUR OPINIONS ON
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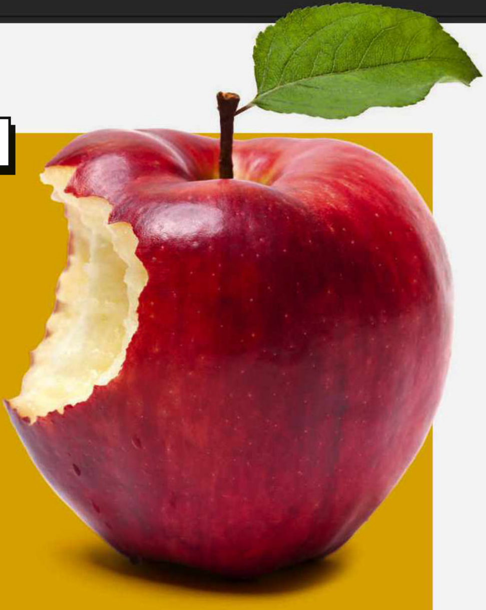
LETTER OF THE MONTH



Teeth are an often overlooked element when it comes to consuming a healthy diet

Reality bites

I read Dr Helen Pilcher's 'Gut Reaction' feature (April, p68) and was particularly struck by its premise that, "Our gut bacteria play a key role in many negative aspects of ageing." As a dentist, I witness every day how oral health directly impacts the dietary choices, gut health and overall wellbeing of older adults.

Helen's feature rightly emphasised the importance of a varied diet that's rich in vegetables and whole grains to support a healthy gut microbiome at any age. But to eat this kind of food, we must first be able to chew it. Sadly, many elderly individuals – especially those who have lost teeth or struggle with ill-fitting dentures – are forced to restrict their diets to softer, often more processed foods. This dietary limitation has long been linked to poorer gut health outcomes, including irritable bowel syndrome, gastric reflux and even an increased risk of bowel cancer.

Investing in oral health, improving access to affordable fresh food and rethinking how we support older people at home will help protect gut health and general wellbeing.

As the old saying goes, "You are what you eat." But first, you have to be able to eat it.

Richard Howarth, Stafford

WRITE IN!

The writer of next issue's Letter of the month will receive a pair of hardback popular science books: **The Game Changers** *by Tim Clare and* **The Bright Side** *by Sumit Paul-Choudhury.*

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DANIEL H. PINK

Bathroom décor

I was very struck by the 'Bowel in Bloom' Eye Opener (see below) in issue 420 (June, p10). I think it would make a tremendous wallpaper design and I would definitely put it in my bathroom. Something to contemplate while on the 'throne' perhaps?

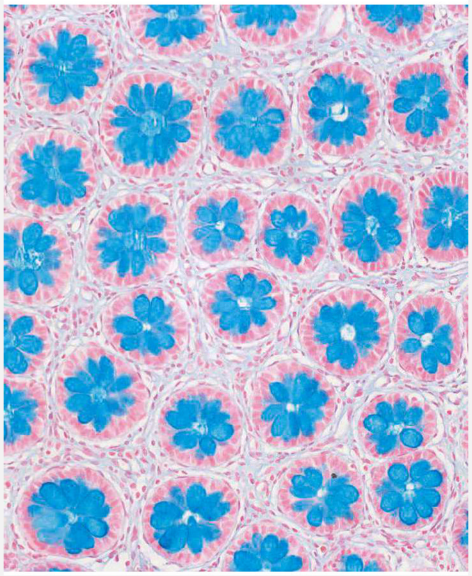
Rita Jones, via email

"It was this big!"

I enjoyed Dr Helen Scales's fascinating article about blue dragons (June, p82), but I was left a little unclear as to their actual size. According to the article, blue dragons are 3cm long, but you indicate that this measurement equates to 0.4in. Not so, as 3cm converts to 1.1811in. So exactly how small are these creatures?

Chas Blackford, California

Editor Daniel Bennett, replies... ***Well spotted, Chas! Unfortunately, that was a mistake we made while converting the measurement. Our fault, not Helen's. The 3cm figure is correct; the 0.4in figure isn't. And you're quite right – it should be 1.18in).***



> *"IT'S VERY RARE THAT PEOPLE WHO CLAIM TO BE EATING THESE DIETS ARE EATING THE BRAIN, THE LUNGS, THE EYES, THE TONGUE, ALL THE INTERNAL ORGANS, THE BONE MARROW…"*
>
> DR EMMA POMEROY, p73

Blue dragon sea slugs are small creatures, typically with bodies no more than 3cm (1.18in) long

Heart of the matter

B Roach's letter (May, p12) struck a chord. Like him, I had no direct evidence of heart attacks in my family until my brother received a triple bypass. Around the same time, I read of two separate cardiologists who said heart attacks are strongly genetic and not environmental.

In light of that, both my wife and I went for CT angiograms to check on the state of our arteries. After having the tests, she reported to me, with her lovely smiling face, that the results showed her calcium deposits were low, but mine were high and, as such, I may be at higher risk of heart attack.

It was a bit unsettling, so we went to a cardiologist who organised a stress echo test for me. In this test, I performed "excellently" in his words, and was told to come back in two years, or sooner if required. What I find intriguing is that the one test result had me with one foot in the grave while the other indicated 'nothing to worry about (yet)'.

Greg Croft, via email

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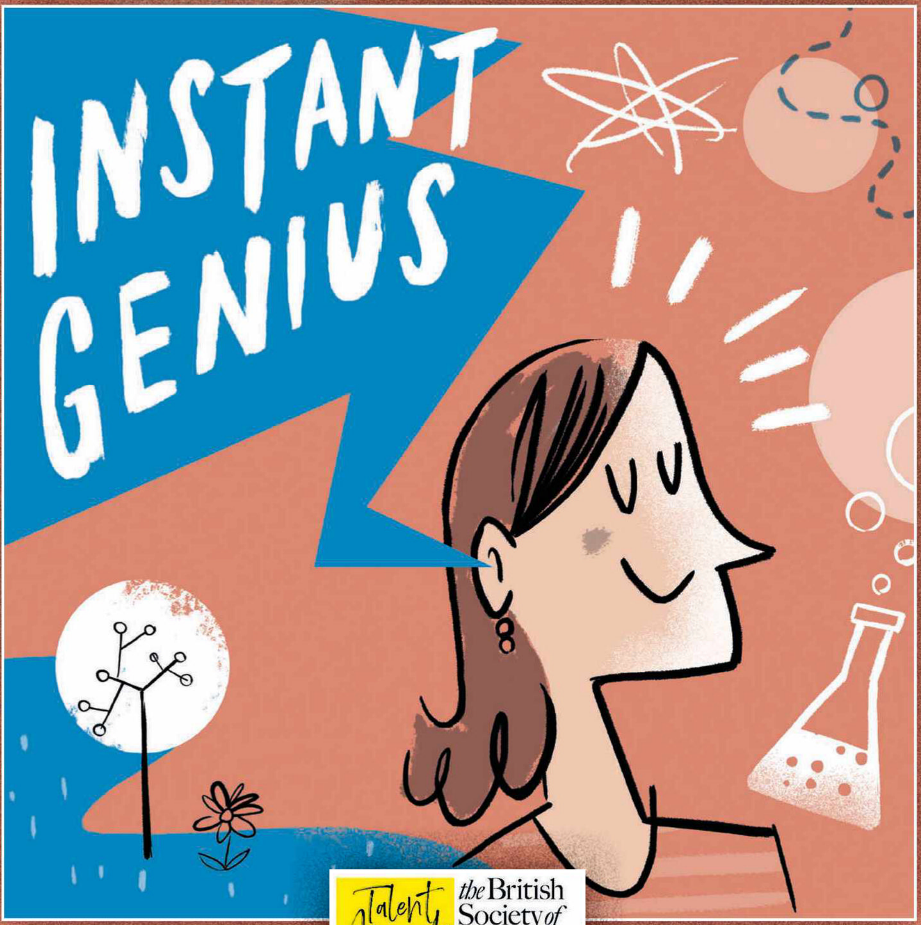

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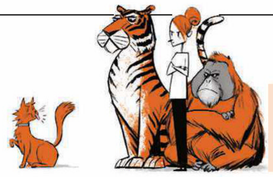
DAILY D
Taking vitamin D every day could help combat the ageing process **p20**



THE GINGER GENDER
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MOON MYSTERY
Scientists are baffled by activity inside the Moon **p23**

NEWS FROM THE FRONTIERS OF SCIENCE

DISCOVERIES

GEOLOGY

‘Doomsday tsunami’ is ready to strike the US

A 100ft mega tsunami could hit the US at any moment – and that’s only the beginning

The Cascadia Subduction Zone, a massive fault line stretching from northern California to British Columbia, has been eerily quiet for 300 years. When it finally ruptures, it’s expected to trigger a colossal earthquake that could rattle the Pacific Northwest for minutes.

Even worse, tsunami waves up to 30m (100ft) high will likely crash to the shore, unleashing destruction along the coast.

But according to a new study published in the *Proceedings of the National Academy of Sciences*, that will only mark the beginning of Cascadia’s cataclysm.

If a wave the same size as Indonesia’s 2004 Boxing Day mega tsunami wasn’t bad enough, the new analysis reveals that land along the coast could drop by more than 2.5m (8ft) in a matter of minutes.

“We talk about climate-driven sea level rise, which is occurring at three to four millimetres (0.11–0.15in) a year, and that does eventually add up,” Dr Tina Dura, lead author of the study, told *BBC Science Focus*.

The Cascadia Subduction Zone is 1,126km (700 miles) long, stretching along the coastlines of British Columbia, Washington, Oregon and California

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"But here we'll have two metres (6.5ft) of sea level rise in minutes. Why aren't we talking about that more?"

WHEN CASCADIA RUPTURES

The Cascadia Subduction Zone marks the boundary where the oceanic Juan de Fuca Plate is slipping beneath the North American Plate. But rather than moving smoothly, these plates tend to get stuck – and as they lock together, the strain grows over centuries.

When it finally releases, the result is a powerful earthquake.

Cascadia is capable of producing quakes of magnitude 9.0 or more, with major events thought to strike every 450 to 500 years. The last one occurred on 26 January 1700, and based on geological records and contemporary reports, its magnitude was likely between 8.7 and 9.2.

According to the US National Seismic Hazard Model, there's now a 15 per cent chance of a magnitude 8.0 or greater earthquake along the zone's margin in the next 50 years.

A 2022 planning exercise by the Federal Emergency Management Agency predicted that such a quake could directly cause 5,800 deaths, and a further 8,000 from the subsequent tsunami.

More than 100,000 people could be injured, and over 618,000 buildings damaged or destroyed – including more than 2,000 schools and 100 critical facilities. The projected economic cost: $134bn (£98bn).

"This is going to be a very catastrophic event for the US, for sure," said Dura.

DECADE-LONG AFTERSHOCKS

While the earthquake and tsunami would be devastating, Dura and her colleagues warn that the long-term aftermath could be just as damaging – and it's far less understood.

By combining geological records of past Cascadia quakes with numerical models, the researchers assessed how the coastal landscape could be reshaped by subsidence: the sudden sinking of land during an earthquake.

If a Cascadia quake happened today, land at 24 estuaries from southern Washington to northern California could permanently drop by 0.23 to 2.67m (0.76 to 8.76ft).

This would dramatically expand 100-year floodplains – areas expected to flood at least once every 100 years – by as much as 300km² (115 sq miles). That means more homes, roads and infrastructure would be pushed into the flood zones. Under high-subsidence scenarios, the team estimates that flood exposure could more than double.

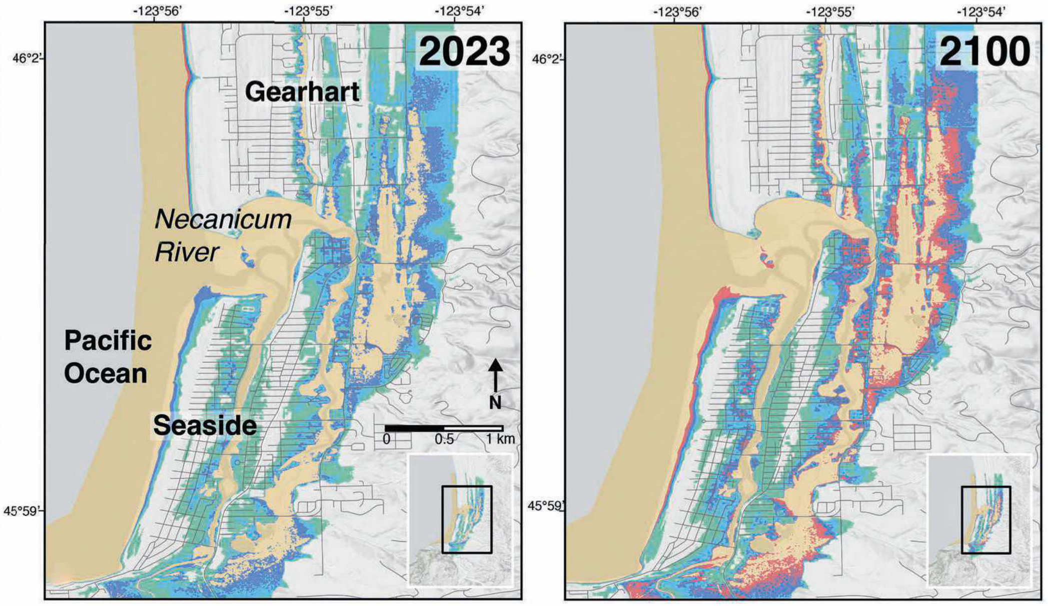
"It's a dual threat," said Dura. "The tsunami is going to come in, and it's going to be devastating. But with tsunamis, we also know that some places are going to be very hard hit, while other places are probably not going to feel as severe effects because of the way the coast is configured. But those areas can still be in the zone of subsidence."

In 1700, there was little infrastructure to damage. Today, the region is packed with critical systems that would be left vulnerable to flooding.

These include: 5 airports, 18 emergency facilities (e.g. schools, hospitals, fire stations), eight wastewater treatment plants, one electric substation and 57 potential contaminant sources such as gas stations and chemical storage facilities.

"More than 100,000 people could be injured, and over 618,000 buildings damaged or destroyed"

ALAMY, TINA DURA



🟡 2023 1% FLOODPLAIN 🔴 2100 CLIMATE-DRIVEN EXPANDED 1% FLOODPLAIN

1% FLOODPLAIN EXPANSION

🔵 LOW SUBSIDENCE 🔵 MEDIUM SUBSIDENCE 🟢 HIGH SUBSIDENCE

ABOVE LEFT The snow-covered Cascade Range of the US northwest as seen from the International Space Station

ABOVE These maps highlight how climate change is likely to decimate essential floodplains

The submerged roads and flooded emergency hubs would make recovering from the disaster extremely difficult, and the saltwater could ruin farmland soil, causing lasting economic damage.

At the same time, natural flood defences, like intertidal wetlands, may drown or erode, weakening protection against future storm surges. Rising tidal ranges could worsen high-tide flooding, and already eroding sandy coastlines would likely shrink even faster.

"After the tsunami comes and eventually recedes, the land is going to persist at lower levels," Dura said. "That floodplain footprint is going to be altered for decades or even centuries."

THE SOONER, THE BETTER

While an earthquake hitting at any moment would be bad, the longer Cascadia stays quiet, the worse the eventual disaster might be.

The researchers modelled what might happen if the earthquake struck in 2100. Thanks to climate change, sea level rise could make everything more destructive.

Global mean sea level has already risen by 21–24cm (8–9 inches) since 1880, and National Oceanic and Atmospheric Administration projections suggest it will rise by another 60cm (2ft) or more by 2100.

In Cascadia, however, the story is slightly more complex: as the Juan De Fuca slips under the North American tectonic plate, the continental land has been slowly pushed upwards, masking the effects of global sea level rise.

But that slow uplift won't last. Eventually, climate change will catch up, and sea levels in the Pacific Northwest will begin to rise just like everywhere else. Slowly but surely, two disasters – tectonic and climate – are converging.

"During the next earthquake, when the land drops down, you're going to suddenly have to contend with multiple centuries of equivalent sea level rise in minutes," Dura said.

By 2100, even without an earthquake, the researchers estimated that floodplains could expand by 100km² (40 sq miles). Combine that with subsidence from an earthquake that hits in 2100, and flood exposure could triple compared to today, expanding floodplains by up to 370km² (145 sq miles).

WHAT CAN BE DONE?

Faced with this compounded threat – earthquake, tsunami, subsidence and sea level rise – what can communities do to prepare?

Dura acknowledged there are no easy answers.

"Cascadia poses a unique challenge because it's so seismically quiet," she said. "It's hard to keep residents aware of the hazard without undue panic. How do you get people prepared without scaring them away?"

As a starting point, Dura's team recommends integrating their findings into flood hazard and tsunami maps and working across agencies to improve preparedness.

Key actions include identifying critical infrastructure in future flood zones and planning how to relocate or adapt them to make them flood-resistant.

Increasing public awareness will also be key, as well as promoting nature-based solutions such as wetland restoration. New infrastructure developments in high-risk areas should also be reconsidered.

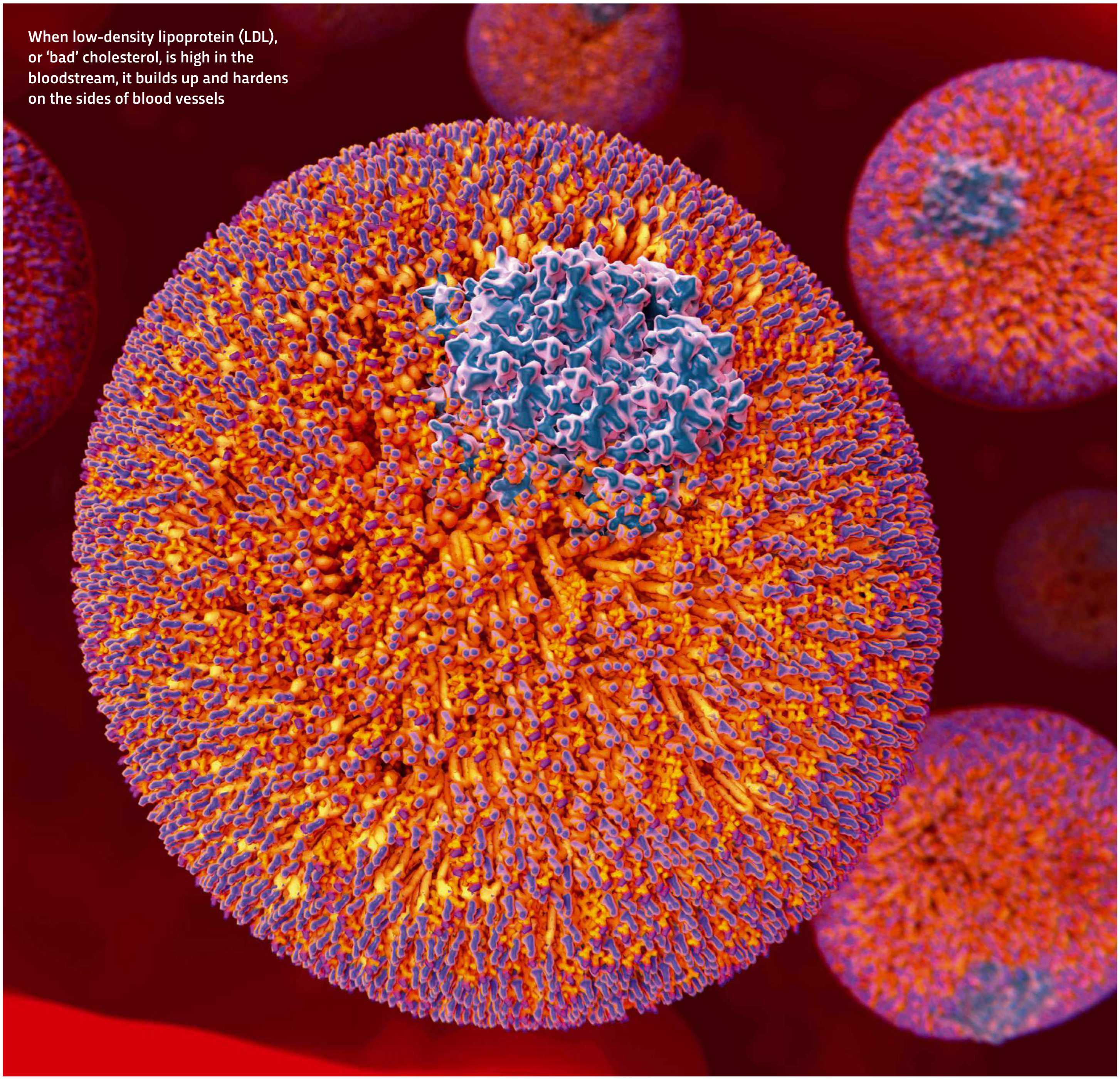
Is all hope lost? Not at all, Dura said – but the clock is ticking.

"There are definitely people working on it, and I don't want to diminish the hard work of those individuals," she said. "I think we just need more people on the problem... But we're all trying to work together. And there's a lot of new science coming out now."

HEALTH

New cholesterol treatment can cut levels by 69% after one dose

The future of heart attack prevention could be a single injection



When low-density lipoprotein (LDL), or 'bad' cholesterol, is high in the bloodstream, it builds up and hardens on the sides of blood vessels

SCIENCE PHOTO LIBRARY X2

“I’ve had patients of mine in the trial receive this one-and-done treatment, and it’s going to change the face of cholesterol management”

A single shot of a new drug can lower cholesterol levels by up to 69 per cent, according to the initial results of a clinical trial that has not yet been peer reviewed.

The treatment, called VERVE-102, could transform the future of heart attack prevention by dramatically lowering the amount of LDL cholesterol – the so-called ‘bad’ cholesterol – with just a single injection.

While statins can lower a person’s cholesterol levels by a similar amount, these generally need to be taken daily.

“This is the future,” Prof Riyaz Patel – an academic cardiologist at University College London and a doctor at Barts Health NHS Trust, which took part in the trial – told *BBC Science Focus.*

“This is reality; it’s not science fiction. We’re actually doing it. I’ve had patients of mine in the trial receive this one-and-done treatment, and it’s going to change the face of cholesterol management going forward.”

Instead of managing cholesterol over time like statins, VERVE-102 aims to provide a one-time fix by ‘switching off’ a specific gene, known as PCSK9, in the liver. This gene plays a key role in regulating how much LDL cholesterol the liver can detect and remove from the bloodstream. Essentially, less PCSK9 leads to less LDL in the bloodstream.

“We’re seeing some spectacular results,” said Patel. “This drug turns off a tiny fraction of DNA, and your LDL cholesterol is lowered by 50 per cent for the rest of your life. That’s it. One and done. This is going to be revolutionary.”

Cholesterol can build up in the walls of blood vessels, forming plaques that may eventually rupture and block blood flow.

High levels of LDL cholesterol increase the risk of this buildup, which is why millions of people (over 40 million in the US, and 7 million in the UK) take daily medications like statins to help keep their cholesterol levels under control.

The VERVE-102 clinical trial involved 14 participants with familial hypercholesterolemia: a genetic condition that predisposes people to heart disease, heart attacks and strokes, due to very high LDL cholesterol levels.

Initial results of the VERVE-102 injection indicate that all participants responded well to the medication, with no serious side effects. Different doses led to different responses; the four individuals given the lowest dose of VERVE-102 saw average reductions in their LDL cholesterol of 21 per cent, while the middle cohort had reductions of 41 per cent, and the highest dose resulted in reductions of 53 per cent.

39%
The number of adults around the world affected by raised cholesterol

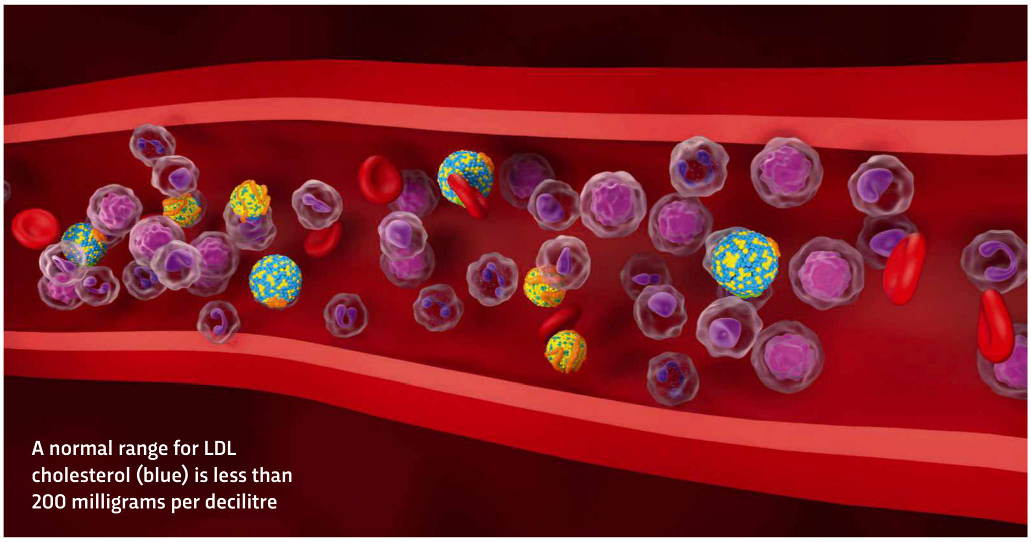
4.4 MILLION
The number of deaths caused by cholesterol in 2019

53%
Average reduction in cholesterol from the highest dose of VERVE-102

But one participant, in the high-dose group, reduced their LDL cholesterol by 69 per cent after receiving VERVE-102.

Dr Eugene Braunwald – Distinguished Hersey Professor of Medicine at Harvard Medical School in the US, who was not personally involved in this study – added the initial trial data was “promising” and that it suggested “the potential for a new era of cardiovascular disease treatment.”

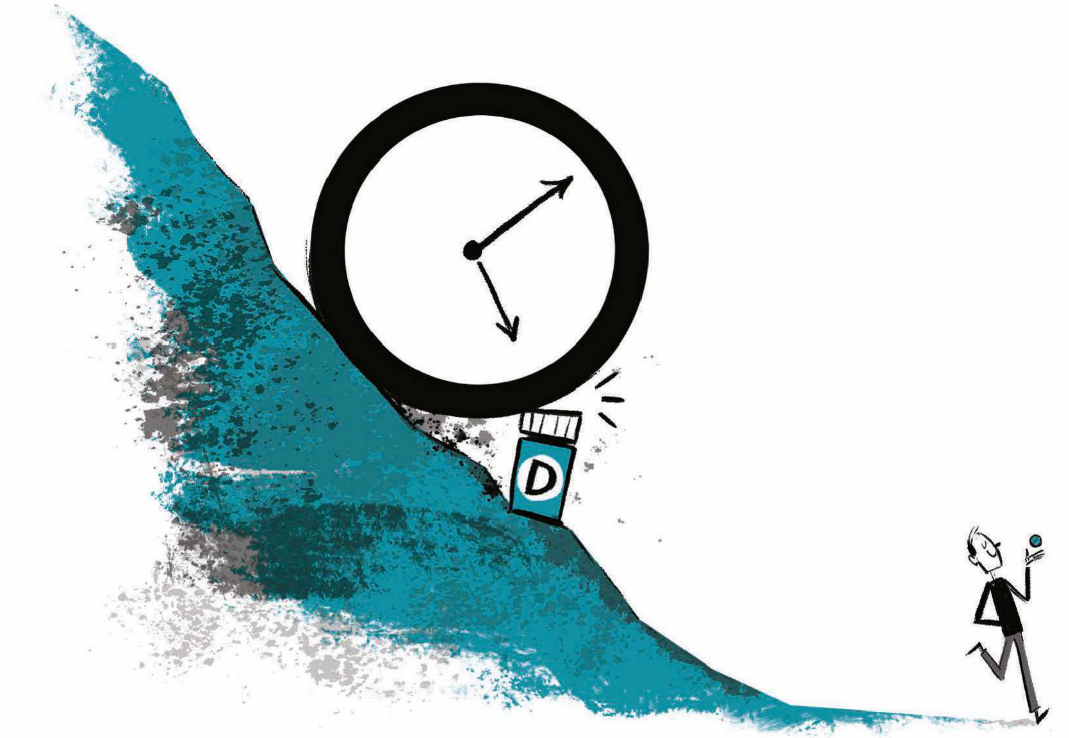
Verve is currently recruiting participants for further clinical trials – who will receive an even higher dose of VERVE-102 – in the UK, Canada, Israel, Australia and New Zealand. It expects to announce its final results later in 2025.


A normal range for LDL cholesterol (blue) is less than 200 milligrams per decilitre

HEALTH

Common vitamin supplement could slow ageing

Vitamin D may protect cells from age-related decline



A daily dose of vitamin D could help combat ageing. New research has found that taking the supplement for four years could prevent as much as three years' worth of biological decline.

Previous studies have hinted that vitamin D supplements can help combat some of the key hallmarks of ageing, which are associated with diseases such as cancer, heart disease and dementia.

To test their theory, researchers from Mass General Brigham and the Medical College of Georgia in the US studied the data of 1,054 people over the age of 50 who, for five years, had taken a daily dose of either vitamin D, omega-3 or a placebo. These participants took part in special tests at three points during the trial (at the beginning, at Year 2 and Year 4) to measure the length of their telomeres.

Telomeres are repeating sequences of DNA that cap chromosomes, Professor Morten Scheibye-Knudsen from the University of Copenhagen, who wasn't involved with the study, explained to *BBC Science Focus*.

"Think of them as the plastic tips on the ends of shoelaces – they prevent chromosomes from fraying or sticking to each other, which helps maintain the stability of genetic information during cell division," he said.

Each time a cell divides, the telomeres get a little shorter. When the telomeres become too short, they lose their ability to divide, meaning their cells can no longer function.

The study, published in the *American Journal of Clinical Nutrition*, found that participants who took vitamin D experienced less telomere shortening, preventing the equivalent of almost three years of ageing.

This could be a key insight into keeping people healthy for longer, as telomere shortening is linked to many age-related diseases.

"I often refer to them as angry old men – cells that have lost their function in life become inactive and make the environment around them bad," said Scheibye-Knudsen.

"Telomere shortening may contribute to more angry old cells and therefore more inflammation in our bodies, particularly in cells that divide a lot, like our bone marrow, skin and hair."

TECHNOLOGY

New contact lenses let people see in the dark… with their eyes closed

The new optical aids could even allow people with colour blindness to see more clearly in the future

Researchers have developed a prototype infrared contact lens that could allow people to see in the dark – even with their eyelids closed.

The cutting-edge prototype, developed by the University of Science and Technology of China, uses nanoparticles that convert infrared into visible light.

Contact lenses imbued with the nanoparticles were given to volunteers to wear during the study, which was published in the journal *Cell*. The participants were then able to see flashing signals from an infrared light, which is invisible to the human eye.

As the lenses were transparent, participants were able to see both visible and infrared light at the same time.

"We found that when the subject closes their eyes, they're even better able to receive this flickering information, because near-infrared

ILLUSTRATIONS: ADAM GALE

NATURE

Ginger cats are genetic freaks

On top of being certified agents of chaos, orange cats are now officially DNA freaks

Ginger cats are the result of a bizarre genetic mutation that doesn't occur in any other species.

That's according to a new study, published in *Current Biology*, which found orangeness occurs because of the rogue expression of a gene called ARHGAP36 – a gene that had never before been connected to making mammals ginger.

Interestingly, this gene is located on the X chromosome, which explains why orange cats are predominantly male.

Like most male animals (including humans), cats have one X and one Y chromosome. Since the gene for orange fur lives on the X chromosome, if a male inherits an X with the orange gene, he'll be fully orange (as there's no second X to interfere).

However, female cats have two X chromosomes. To be completely orange, they need to get the orange gene on both of their Xs. That's why their fur tends to show a mixture of colours – like the patchy orange, black and white patterns seen in calico or tortoiseshell cats.

While orangeness in cats is linked to their sex, this doesn't seem to be the case with other orange mammals, like tigers, orangutans and red-headed humans. Orange cats seem to be "a genetic exception," said Dr Christopher Kaelin, a senior scientist in genetics at Stanford Medicine and the study's lead author.

To find out if the ARHGAP36 mutation affects more than just fur colour, scientists examined various organs – like the kidney, heart, brain and adrenal glands – in both orange and non-orange cats. They found no significant differences.

Kaelin said that the apparent tendency of orange cats to be more mischievous could be due to the fact that they're mostly male. He also noted that there aren't many scientific studies on the behaviours of orange cats.

"Orangeness occurs because of the rogue expression of a gene called ARHGAP36"

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light penetrates the eyelid more effectively than visible light, so there is less interference," said Professor Tian Xue, who led the study.

The nanoparticles take in near-infrared light, which has wavelengths of 800–1,600 nanometres (just beyond what humans can see). The light is then re-emitted in the visible range, from 400–700 nanometres.

Near-infrared light is currently used in active night vision goggles. These work by illuminating the surrounding landscape with an infrared light, then converting that light into something humans can see.

Unfortunately, if you were hoping to see the world in 'heat-vision', like the aliens in the *Predator* films, you'll be disappointed – that requires longer wavelengths. Currently, the contacts are only sensitive enough to detect light from an infrared LED.

The contacts also struggled to capture fine detail, though the team were able to improve this with the use of an additional pair of glasses.

In the future, it may be possible to adapt the nanoparticles to emit light in many different colours, which would help to make the infrared images clearer. It might even be possible to alter visible light, such as converting red light into green light, which could help people with colour vision deficiency (CVD), aka colour blindness, see what was previously invisible to them.

FOOD

Only one country in the world produces all the food it needs

All other countries are vulnerable to the effects of war, natural disasters and trade disputes on their food supply

Out of 186 countries, only Guyana, in South America, produces enough food to self-sufficiently feed all its citizens without foreign imports, according to new research.

The study, published in *Nature Food*, investigated how well each country could feed its population with seven food groups: fruits, vegetables, dairy, fish, meat, plant-based protein and starches.

Globally, the study found that 65 per cent of countries were overproducing meat and dairy, in terms of their population's dietary needs (as defined by the World Wildlife Fund's Livewell diet, which is designed for health and sustainability).

It also found that Guyana was the only country that could boast total self-sufficiency. China and Vietnam were close behind, being able to produce enough food in six out of seven food groups.

Very few countries – just one in seven – were judged self-sufficient in five or more of the food groups.

The study also found a global shortfall in nutrient-dense plants, with fewer than half of the countries producing enough plant-based protein (such as beans, chickpeas, lentils, nuts and seeds) or starchy carbs. Only 24 per cent were growing enough vegetables.

Countries in Europe and South America were generally closer to being self-sufficient than other continents. But small island states, countries on the Arabian Peninsula and low-income countries were more likely to rely on foreign imports for their food.

Six countries – Afghanistan, United Arab Emirates, Iraq, Macao, Qatar and Yemen – were found to not be self-sufficient in any category.

The advantages of self-sufficiency have come to light in the wake of the COVID-19 pandemic and the onset of the Russia-Ukraine war, where instability has disrupted the reliable import of food.

Dr Jonas Stehl – researcher at the University of Göttingen, Germany, and first author of the study – told *BBC Science Focus* that the "resurgence in interest" in national food self-sufficiency might also reflect broader political shifts, "including growing nationalism

BIOPHYSICS

All humans emit subtle light until they die

When people tell you you're glowing, they're not wrong

You, along with all living things, produce subtle, ethereal, semi-visible light that glows until you die, according to a recent study.

Rather than a luminescent aura, this light is called ultraweak photon emission (UPE) and is a natural product of your metabolism. UPE is produced when chemicals in your cells create unstable molecules known as reactive oxygen species (ROS) as by-products of your body's metabolism.

When ROS levels rise, they cause other molecules to become 'excited', meaning they carry excess energy. It's this energy that causes light to be emitted.

"I normally point out that UPE is a result of a biochemical process and in that sense is related to what happens inside a glow stick, which no one suspects of having an aura," Dr Daniel Oblak, physicist at the University of Calgary and last author of the study, told *BBC Science Focus*.

"UPE is so weak that it isn't visible to the human eye and is completely overwhelmed by other sources of light, unless you are in a completely dark room."

Unfortunately, shutting your curtains and turning off your lights won't allow you to see your own

ILLUSTRATIONS: ADAM GALE

and a desire among some to reduce dependence on foreign countries."

"Low self-sufficiency is not inherently bad," Stehl added. "There are valid and often beneficial reasons why a country may not produce the majority of the food it needs."

For instance, a country might not have enough rain, good-quality soil or stable temperatures to grow enough food for its population. Stehl said it could also be cost-effective to import food from regions better suited to producing it.

"Low levels of self-sufficiency, however, can reduce a country's capability to respond to sudden global food supply shocks, such as droughts, wars or export bans," he said.

> "There are valid and often beneficial reasons why a country may not produce the majority of the food it needs"

glow. This light is between 1,000 and 1,000,000 times dimmer than the human eye can perceive.

A key driver of UPE's effect is oxidative stress – a form of cellular wear and tear caused by factors like ageing and illness. The more oxidative stress the body experiences, the more ROS it produces, and the more light it emits.

For the study, the scientists measured UPE using specialist cameras on living and dead mice.

The researchers say that measuring UPE could help to monitor health in any living thing, from biological stress in humans to the condition of an agricultural crop.

SPACE

Research team 'puzzled' by strange activity inside the Moon

Scientists may have discovered why the two sides of the Moon look so different

A new NASA study revealed that the side of the Moon facing Earth is 'flexing' more than the far side, suggesting a surprisingly wonky internal structure between the two hemispheres.

"We had long assumed that the Moon was spherically symmetric deep inside, so seeing clear evidence to the contrary was both surprising and challenging," Dr Ryan Park, lead author of the study and head of the Solar System Dynamics Group at NASA's Jet Propulsion Laboratory, told *BBC Science Focus*.

Published in *Nature*, the study focused on an ultra-precise gravity measurement known as the 'tidal Love number', which quantifies how much a planetary body flexes due to tidal forces. After nearly a decade running complex calculations with millions of parameters, the team found that the Love number is 72-per-cent higher than it should be for a symmetrically spherical Moon.

"When we first recovered the higher-than-expected lunar tidal Love number, our team was genuinely puzzled," Park said.

The cause? The near side's mantle is warmer and less rigid than the far side's, likely due to radioactive heating early in the Moon's history.

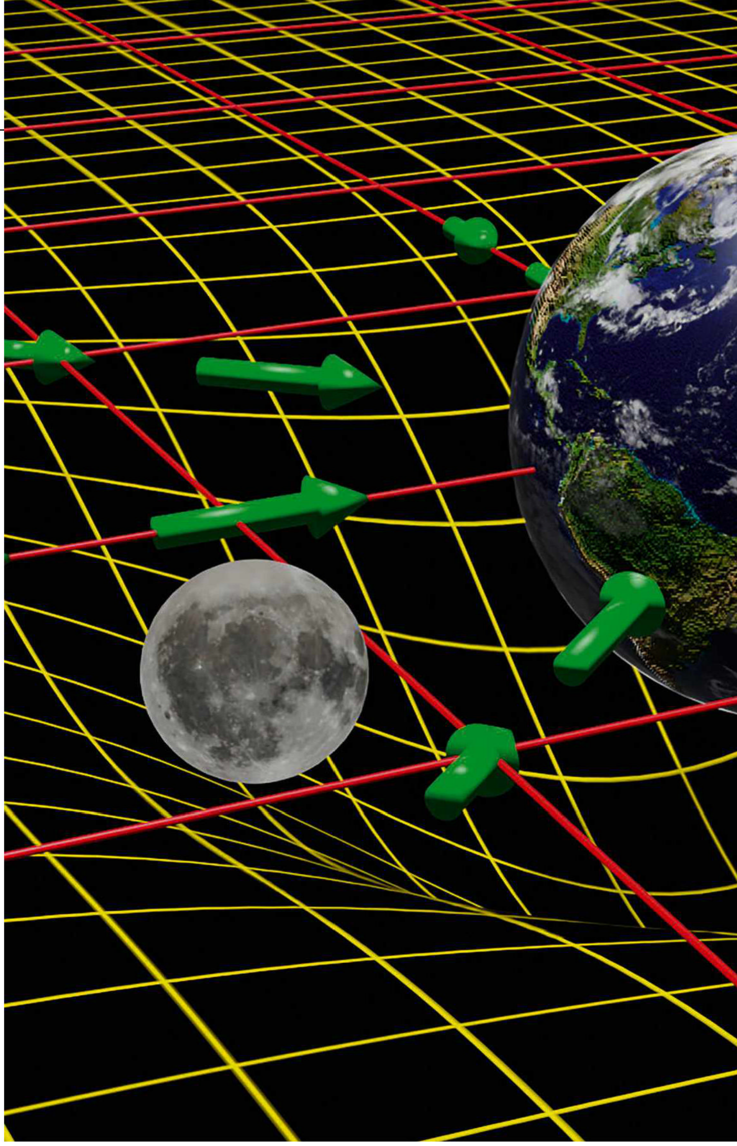
Billions of years ago, that heat may have created pockets of partially melted rock, fuelling massive volcanic eruptions. As the near side has more radioactive material, it created dark plains called 'lunar maria', while the far side remained rugged and cratered.

The research provides the most detailed gravitational map of the Moon ever produced. It could help future missions land and navigate more precisely, and even inform the development of a lunar navigation system.

PHYSICS

New theory could finally make 'quantum gravity' a reality... and prove Einstein wrong

A united Theory of Everything is the 'Holy Grail of physics'



The difficulty in creating a theory of 'quantum gravity' is that the two ideas look at the Universe at completely different scales.

Quantum mechanics looks at the smallest scales of the particles that make up atoms. Physicists have used it to create the Standard Model, which gels together three of the fundamental forces that govern our Universe: electromagnetism, the strong force (which holds protons and neutrons together) and the weak force (responsible for radioactive decay).

The fourth fundamental force is gravity, as laid down by the laws of General Relativity written by Albert Einstein. This thinks of gravity as the warping of space-time. Large masses and high-energy objects distort space-time as they move through it, and affect the objects around them. It controls everything that happens in our Universe, from planets to stars and galaxies. And it refuses to play nicely with the laws of quantum mechanics.

A TALE OF TWO THEORIES

One of the biggest problems is that gravity is a 'deterministic classical' theory. Its laws state with certainty what the consequences of an action will be. Drop a ball, and gravity means it will definitely fall to the ground.

Quantum theory, however, is probabilistic in nature. It doesn't predict the precise outcome of a situation, only the likelihood of it happening.

"These are challenging to combine," Dr Mikko Partanen, lead author of a study published in *Reports on Progress in Physics* told *BBC Science Focus*. "Attempts to apply quantum theory in the presence of gravitational interaction have led to many nonsensible results."

For instance, when quantum physicists try to measure an electron's mass, their equations spin off into infinity. On the other hand, when gravity is applied to calculations of extreme gravitational situations, such as at the edge of a black hole, Einstein's equations stop making sense.

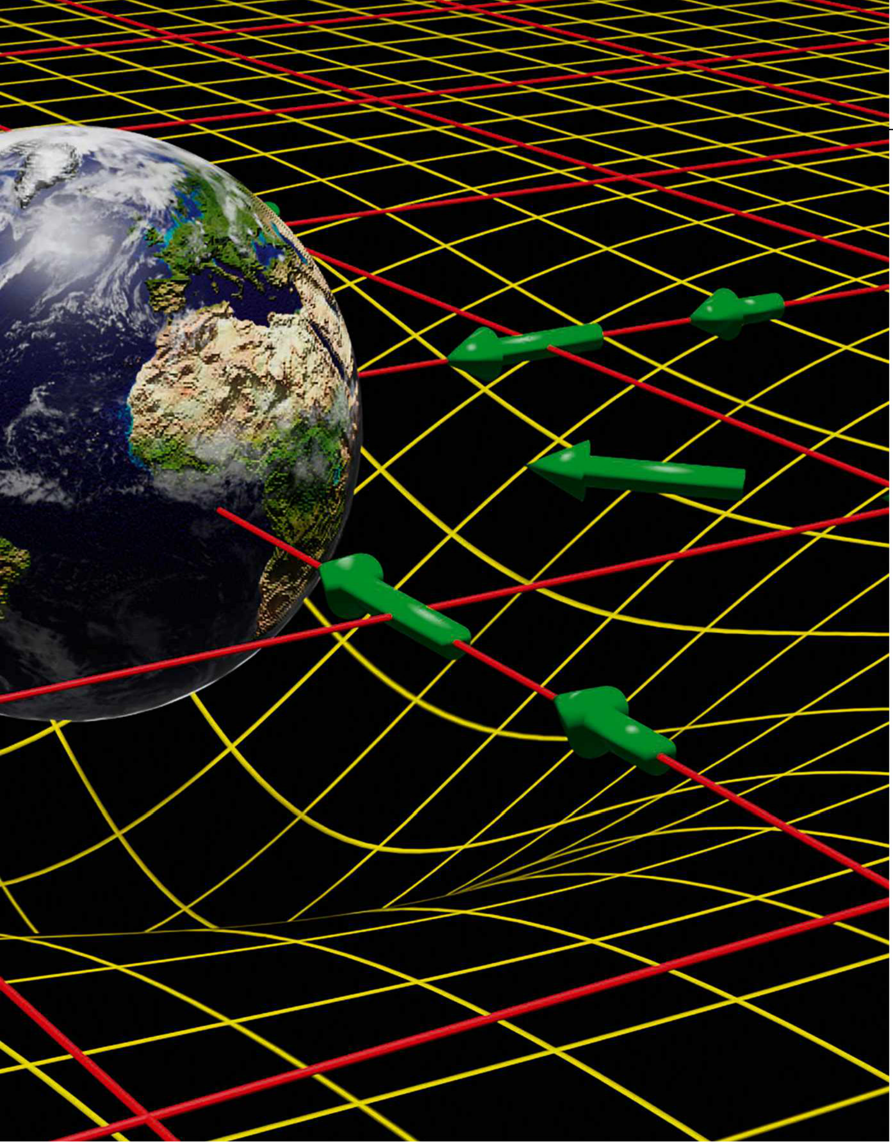
"Some appealing approaches to solving the problem, such as string theory [which replaces particles with vibrating strings of energy], don't currently make unique, testable predictions that could distinguish these theories from the Standard Model or General Relativity," Partanen said.

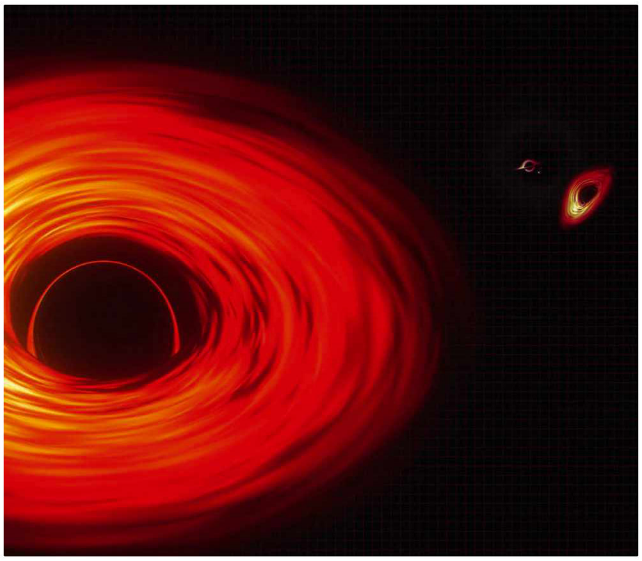
Rather than devising an entirely new theory to connect these models, Partanen and his colleague Prof Jukka Tulkki looked at gravity in the same way they think about quantum mechanics. They did this by reformatting the equations of gravity to use fields.

In quantum theory, fields describe how a physical quantity changes over space and time. You might already be familiar with

> "Physicists should already have the tools needed to test this new field-based theory"

LEFT
Aalto University researchers Dr Mikko Partanen and Prof Jukka Tulkki





LEFT The new theory creates a gravitational quantum field by using flat space-time in its calculations

ABOVE Even General Relativity has been unable to explain what happens inside a black hole

electric and magnetic fields.

Using these fields, the pair were able to recreate the rules of General Relativity, only now in a format that is much easier to combine with quantum mechanics.

TESTING THE THEORY

One of the most exciting parts of the theory is that it doesn't introduce any strange new particles to discover or physical laws to work out. This means that physicists should already have the tools needed to test this new field-based theory of quantum gravity.

"We've already succeeded in showing that – without introducing a single new parameter to be determined experimentally – our theory explains known classical effects of gravitational interaction," Partanen said.

According to Partanen, the new theory creates equations which help to explain phenomena such as redshift – the stretching of light to longer, redder wavelengths as objects move away from us in the expanding Universe.

But that just proves the theory is valid, not that it's right.

To do that, physicists will need to look at extreme gravitational situations where General Relativity stops being as accurate.

If this new field-based theory of quantum gravity works as a better predictor in these situations, that would be the first step in confirming it and proving Einstein wrong (or at least showing his theory was incomplete).

Practically, though, this will be a difficult task, as the mathematical difference between the two theories is incredibly small.

For instance, if physicists were to look at how much the mass of the Sun bends light from a distant star, the two theories would predict an answer different by only 0.0001 per cent. To make matters worse, astronomers can't currently make measurements that accurate.

THE NEXT STEPS

Fortunately, there are massive objects throughout the Universe where observable differences are much more noticeable.

"In the case of neutron stars, where the gravitational fields are stronger, the relative difference can become as large as a few per cent," Partanen said.

While there aren't currently any observatories capable of measuring these big differences, existing technology could build one.

The theory is still in its early stages. The team will now begin working up a complete mathematical proof, checking that the theory doesn't start producing infinities or other large mathematical headaches.

If things still look promising after the initial proof, the team will then begin to apply their theory to extreme situations, such as black hole singularities.

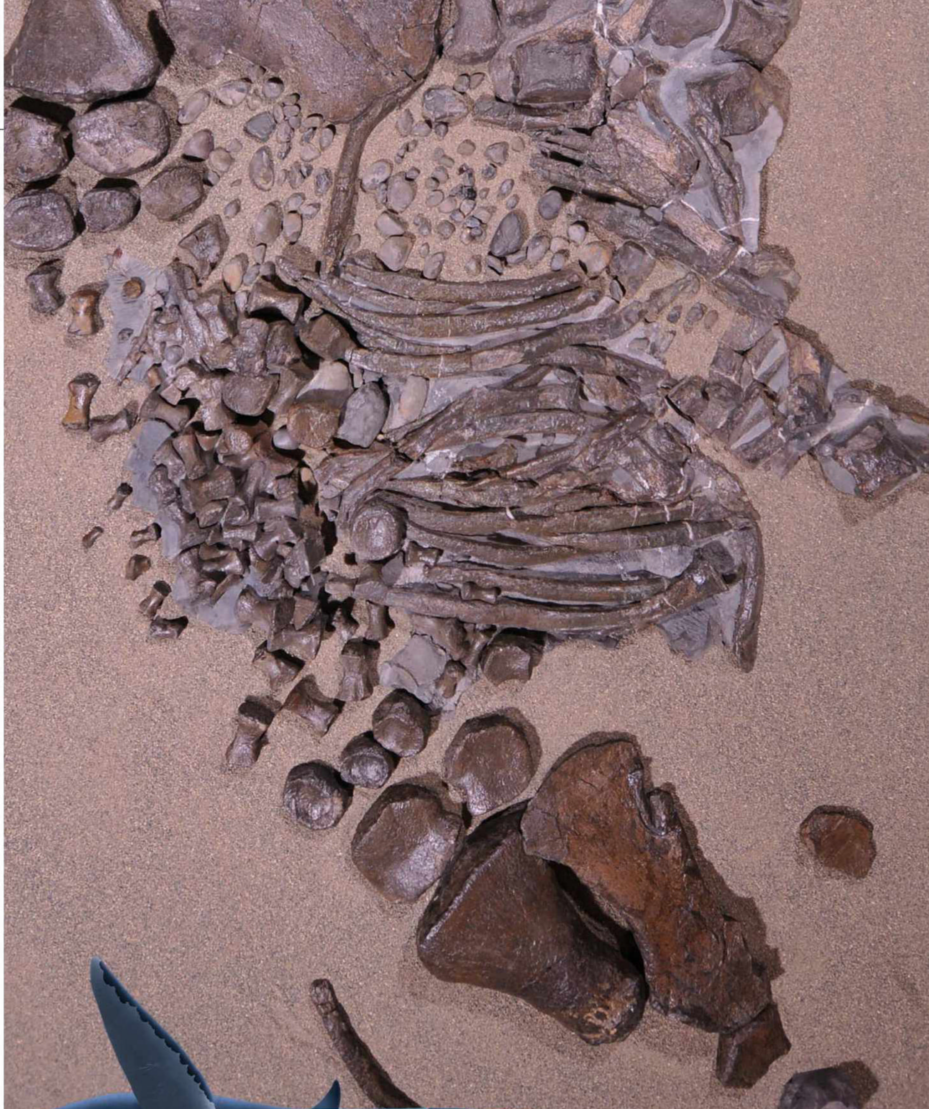
The theory could also lead to exciting new discoveries. "Since our theory represents a completely new kind of attempt to unify all four fundamental forces of nature within a single framework, its closer examination may reveal phenomena that we cannot yet even imagine," said Partanen.

MIKKO PARTANEN/JUKKA TULKKI/AALTO UNIVERSITY, MATTI AHLGREN, NASA

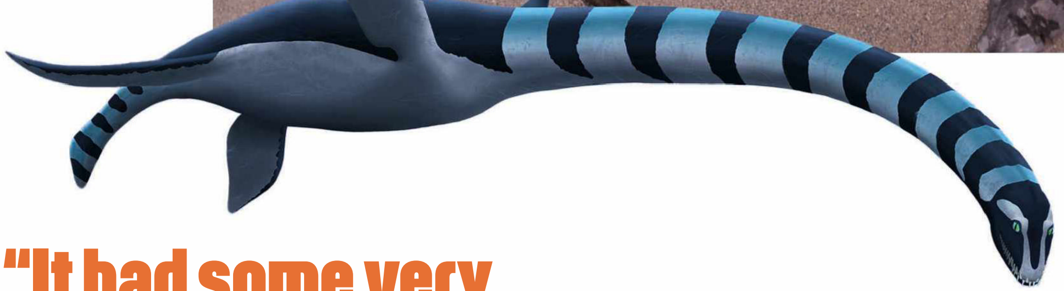
PALAEONTOLOGY

Decades-old sea monster mystery solved

Discovered in the 80s, the creature was unlike anything scientists had seen before



TOP A juvenile *Traskasaura* fossil discovered in 2020



ABOVE The genus name *Traskasaura* honours Michael and Heather Trask, who discovered the species

A bizarre ancient marine reptile has been formally identified, decades after fossils of the creature were first discovered in Canada.

The 12m-long (40ft) vertebrate, *Traskasaura sandrae*, was a long-necked plesiosaur – a type of aquatic predator that lived at the time of the dinosaurs – with a bizarre anatomy and a rare top-down hunting style.

"The fact that it had some very odd traits – it was a very weird-looking animal – made it basically impossible for researchers at the time to decide what it was and who it was related to," Prof F Robin O'Keefe, a palaeontologist at Marshall University, in the US, and lead author of the study, told *BBC Science Focus*.

The first fossil was discovered in 1988 along the Puntledge River on Vancouver Island, having lain in the ground for 85 million years. It was strikingly complete – skull, neck, limbs and tail – but degraded on one side. "It looked good from far away," O'Keefe said, "but the closer you got, the sadder it became – like a melted ice cream. That made it almost impossible to identify."

It wasn't until a second, juvenile skeleton was unearthed that things began to fall into place. This one was much better preserved, helping the team verify and understand the bizarre traits of the adult individual.

> "It had some very odd traits. It was a very weird-looking animal"

Among its many oddities were its flippers, which were shaped like inverted aeroplane wings with the more curved surface on the underside rather than the top. This suggests *Traskasaura* hunted in a highly unusual way: by diving down on its prey from above.

"In the water, animals tend to hunt upwards because they're looking at prey silhouetted against the light on the surface," O'Keefe said. "This animal didn't do that."

Its prey likely included ammonites – extinct, coiled-shelled relatives of modern-day squid and octopus – which it would have crushed with its heavy, sharp teeth.

ROBERT O CLARK, THE COURTENAY AND DISTRICT MUSEUM

NEW 2000T

EVEN MORE SATISFACTION IN BED

The new 2000T is the result of perfecting perfection itself, with three big upgrades: optimized spring movement, consistency in firmness levels and more traditional craftsmanship. Each pocket spring now moves even more flexibly while continuing to provide steady support for your spine. Your back releases residual tension, and your chest and facial muscles soften. As you unwind, you slip even more swiftly into undisturbed sleep, the kind where your body and mind can truly regenerate, before waking up with a natural surge of energy. You are invited to experience the new 2000T in your nearest Hästens Sleep Spa®.

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REALITY CHECK

THE SCIENCE BEHIND THE HEADLINES

REVIEW

Does having a 'dog baby' make us happier than having a human baby?

While fertility rates across the world are falling, more and more of us are choosing to parent pooches

BBC

For more fact-checking news, visit the BBC's Verify website at ***bit.ly/BBCVerify***

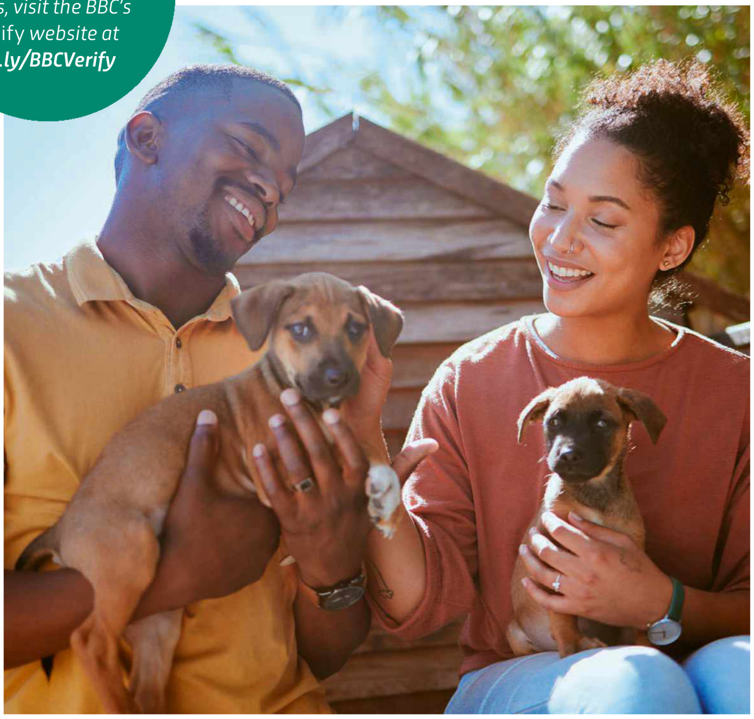
I'll never forget the day my wife and I drove to pick up our miniature schnauzer puppy. She was just four weeks old and could sit in my palm. On the way home, I sat with her on the back seat as she cosied up to my lap, looking up at me with those big, adorable eyes.

In the weeks and months that followed, we used to joke that having a puppy felt like a dress rehearsal for having a baby.

These days, an increasing number of people seem to be thinking this way, identifying as 'dog parents' and seeing their furry friends as substitute children.

In a new paper in the *European Psychologist*, a pair of researchers at Eötvös Loránd University in Budapest – Laura Gillet and Prof Enikő Kubinyi – have drawn attention to this trend and raised the question of whether it's related to the parallel decline in human fertility rates worldwide.

As it happens, my wife and I ended up having human twins a few years after we got Ruby. But amid the ongoing cost-of-living crisis and a growing emphasis on individualistic values, could it be that many people are choosing to have dogs instead of raising children?



ABOVE There's an argument to be made that humans have evolved an instinctive urge to nurture

LEFT Dogs share some of the same cute features as babies (big eyes, tall foreheads) that bring out people's broody sides

GETTY IMAGES, ALAMY

> "There are over a million more pet dogs in the country today than there was a decade ago"

SUBSTITUTE CHILDREN

In the UK, fertility rates are at historic lows. In 2023, we were averaging 1.44 children per woman (the figure needs to be over 2 to sustain a population), with the number of live births at 591,072, the lowest annual figure since 1977. At the same time, however, dog ownership is on the rise, especially among younger generations.

There are over a million more pet dogs in the country today than there were a decade ago, and 45 per cent of owners are millennials (born between the early 1980s and mid 1990s). Anecdotally, we're increasingly treating dogs like people. At our local café you can order a 'puppuccino' and many owners are setting up their dogs' own social media accounts.

In their paper, Gillet and Kubinyi make the case that humans have an evolved instinct for caregiving, while at the same time, through thousands of years of domestication, dogs have evolved to press many of our caregiving buttons.

For instance, we're drawn to the cute characteristics of baby faces, such as large eyes and tall foreheads, which dogs share. Indeed, many popular breeds display 'paedomorphosis', which is the retention of juvenile appearance through adulthood.

There's neuroscientific evidence to suggest dogs are well-placed to act as substitute children. A brain imaging study from 2014 showed that when mothers looked at their dogs, it activated similar neural networks as when they looked at their human children, especially across mid-brain regions related to the experience of reward.

Another study from 2015 found that when owners gazed into the eyes of their dogs, it triggered increases in the neurohormone oxytocin, which has many functions but is often associated with bonding and is known to be important for mother-infant interactions. You may also have noticed that many owners talk to their dogs in a manner that resembles the way mothers talk to their infants, with higher-pitched and infant-directed speech known as 'motherese'.

Gillet and Kubinyi draw many other parallels between the parenting of humans and the owning and caring of dogs. For instance, psychologists have previously shown that human children can develop different attachment styles, such as secure and insecure, that relate to their behaviour when they're with, or away from, their parents. These attachments are largely shaped by the emotional consistency shown by their parents.

Similarly, research with dogs shows that they form close attachments to their owners that match the categories seen in humans. Just as with humans, the dogs' attachment style is influenced by their

> “[Parents] experience a decline in happiness over the first few years of parenthood, likely due to the demands of the job”

owners’ caring approach, such as how nurturing or authoritarian they are.

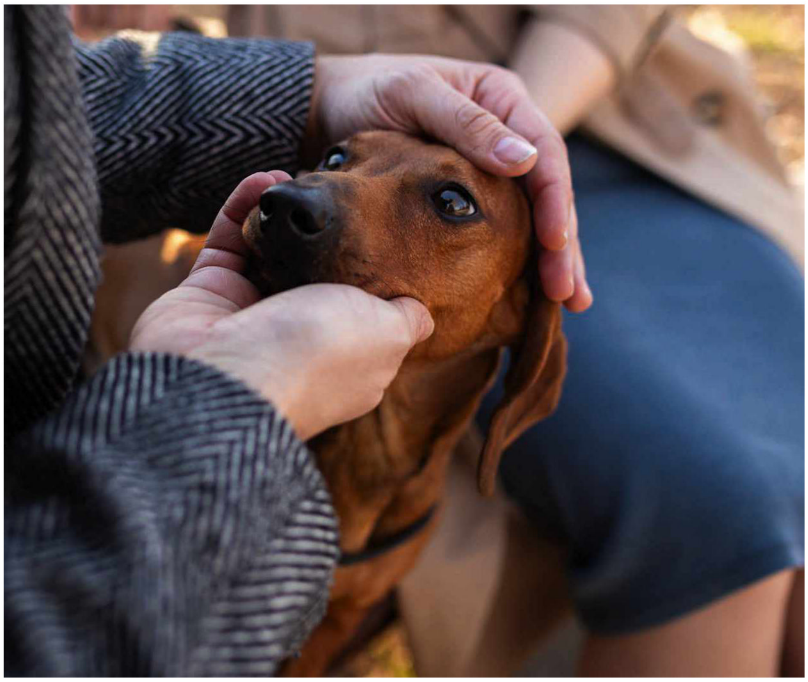
There’s even evidence that dog owners can experience something akin to the ‘baby blues’ – the intense and sometimes difficult emotions experienced by mothers in the first few weeks after childbirth. As a 2024 study put it, “emerging evidence suggests that puppy owners may undergo ‘puppy blues’, encompassing feelings of emotional strain, anxiety about responsibility and challenges in adapting to the changes brought by a new puppy.”

If caring for a puppy can simulate many aspects of becoming a mum or dad, is it a shrewd move to become a dog parent rather than a baby parent? It’ll certainly cost you less money and interfere less with your career. And I can say from personal experience that poop-a-scooping is probably easier than nappy changing, though neither is a bundle of laughs.

But are dog parents destined to be happier than human parents? This is where the picture starts to become a bit more complicated.

EMOTIONAL CHALLENGES

Parenthood of the human variety seems to bring a short-term happiness penalty. Parents-to-be tend to experience a period of anticipatory joy, but then experience a decline in happiness over the first few years of parenthood, likely due to the gruelling demands of the job.



BELOW Dogs need walking, which creates opportunities for exercise and meeting other dog owners. Both of which can help your happiness

by **DR CHRISTIAN JARRETT**

Christian is a cognitive neuroscientist, and author of Be Who You Want: Unlocking the Science of Personality Change.

This penalty gradually fades and they return to their pre-parenthood levels of happiness. These experiences often come as something of a shock to many people who assume that becoming a parent is the most joyful thing you can do in life.

But a lot of this comes down to how you choose to measure happiness, including whether you’re talking about in-the-moment pleasure or the long-term satisfaction of reflecting on a life well spent. Many parents will say that having children was the most meaningful experience of their lives.

What about dog owners? Again, the picture is complicated and a lot of the big longitudinal studies involve pets generally, rather than dogs specifically. That said, there are parallels with the parenting literature in that the pet ownership experience isn’t always as rosy as you might expect.

For instance, a systematic review of 54 studies of the quality of life of dog and cat owners found that only 31 per cent showed a clear positive impact, compared to nine per cent showing a negative impact.

As with the parenting story, the mixed findings for dogs (and pets generally) are probably due to the emotional challenges of being a dog owner, including the demands of nurturing them and the worries of keeping them safe.

There are also other factors, such as your financial situation and the kind of society you live in. Parental happiness tends to be higher in nations that have more child-friendly policies.

For both dog and human parents, age could make a difference, as well. For instance, people who become parents in their thirties tend to be happier than those who become parents in their early twenties. Among elderly dog owners specifically, there’s clear evidence that their canine companions can help alleviate loneliness.

There are also other boons from owning a dog, such as encouraging more physical exercise and giving you the opportunity for chance social encounters with other dog walkers.

In the case of babies versus puppies, weighing them against each other as tools for achieving happiness is probably the wrong perspective. What they both offer – in their own cute and trying ways – is an outlet for the deep-seated human instinct to care and nurture, one of the better angels of our nature that’s worth celebrating, however we choose to satisfy it.

GETTY IMAGES X2

All residents – public and private water:
Vote NO
on Fluoridation
www.kkw.org
www.rethinkingfluoride.com

ABOVE The widespread use of products containing fluoride, such as toothpaste and mouthwash, has raised concerns about the mineral's presence in drinking water

ANALYSIS

Here's what could happen to your teeth if fluoride disappears from drinking water

Dental experts are sounding the alarm about removing fluoride from drinking water. But how much of an impact will the ban actually have?

Utah became the first US state to ban fluoride from being added to public drinking water in March this year. Soon after, Florida followed suit, with US Health Secretary Robert F Kennedy Jr telling the Centers for Disease Control and Prevention (CDC) to stop recommending fluoridation nationwide.

As opposition to water fluoridation in the US rises, scientists are concerned that its removal will lead to a sharp increase in tooth decay, costing the states billions of dollars and disproportionately affecting poorer communities.

With states such as Nebraska, Kentucky and Louisiana looking to remove fluoride from their water, the question of how quickly this change will affect Americans has been raised.

FLUORIDE CONCERNS

Fluoride is a naturally occurring mineral found in fresh water and was first added to community drinking water, in controlled amounts, in the US in 1945 as an effective way to help prevent tooth decay.

In 1999, the CDC stated that, by helping to strengthen developing baby teeth and protect them into adulthood, community water fluoridation was one of the 20th century's greatest public health achievements.

In recent years though, the addition of fluoride to foods, milk and dental products such as toothpaste and mouthwash, has led to concerns that the combined total intake of fluoride per person may exceed safe amounts.

The National Toxicology Program (NTP) in the US released a review of published scientific studies on the links between fluoride and neurodevelopment and

cognition. The findings showed that higher levels of fluoride exposure, such as drinking water containing more than 1.5mg of fluoride per litre, were associated with a lower IQ in children.

The NTP conceded, however, that there was insufficient data to determine if the low, US-recommended fluoride levels of 0.7 mg/L has a negative effect on children's IQ. And, of the 74 non-US-based studies consulted, it said, "52 were rated as low quality (high risk of bias)".

Vida Zohoori, professor in public health and nutrition at the UK's Teesside University and known for her research on fluorides, says these studies offer insufficient data from which to draw conclusions.

"Most were conducted in regions where fluoride concentrations are well above US standards, limiting their relevance to community water fluoridation at 0.7mg/L," she says.

"The majority of studies were cross-sectional, rather than longitudinal or randomised, making it impossible to establish causality. Many also failed to control for key variables, such as exposure to iodine or lead, poor nutrition and socioeconomic status – all of which can independently influence child cognitive development."

But the evidence in favour of adding safe amounts of fluoride to drinking water is robust. Based on a systematic Cochrane review from 2015 (and later updated in 2024), Zohoori projects that if fluoride were removed from public water supplies, we would see large increases in childhood tooth decay.

It's a sentiment shared by Dr James Bekker, associate professor at the University of Utah School of Dentistry and specialist in pediatric dentistry. "There are no scientifically viable studies that show detrimental effects of fluoride if added in safe dosages," he says.

Bekker explains that fluoride in toothpaste provides a topical effect during brushing, whereas small traces in drinking water and supplements offer continuous and systemic exposure, strengthening tooth enamel and making it more resistant to acids.

According to the CDC, water fluoridation reduces tooth decay by about 25 per cent in children and adults. School children living in communities where water is fluoridated have, on average, 2.25 fewer decayed teeth.

"Many children don't have access to fluoride supplements," Bekker says, adding that before the ban, water fluoridation was only present in half of Utah. "In the non-fluoridated water populations we've already seen a significant increase in dental decay, compared to those who have access to fluoridated water. If untreated, cavities get larger and eventually reach the nerve of the tooth, which can lead to infection and potential tooth removal."

If all 50 US states stopped community water fluoridation programmes, children and adolescents aged 0–19 could expect to develop 25.4 million more

ABOVE Not every country adds fluoride to its drinking water, since the mineral is already present naturally, in varying levels

RIGHT Fluoride crystals, seen under a microscope

> "The support for fluoride across the dentist community is proof of its success and safety, because it goes against the financial interest of dentists"

GETTY IMAGES, SCIENCE PHOTO LIBRARY

cavities within the next five years. This would be the equivalent of a new cavity for one in every three American children, costing a total of $9.8bn (£7.2bn), according to a new study published in *JAMA Health Forum* in May.

"We specifically measured the increase in dental cavities – the kind that might need anything from a filling to a root canal or even a tooth extraction," says Dr Lisa Simon, fellow in oral health and medicine integration at Harvard School of Dental Medicine and co-author of the study. "We included decay in both baby teeth and adult teeth, which start growing when children are around six years old."

TOOTH DECAY ON THE RISE

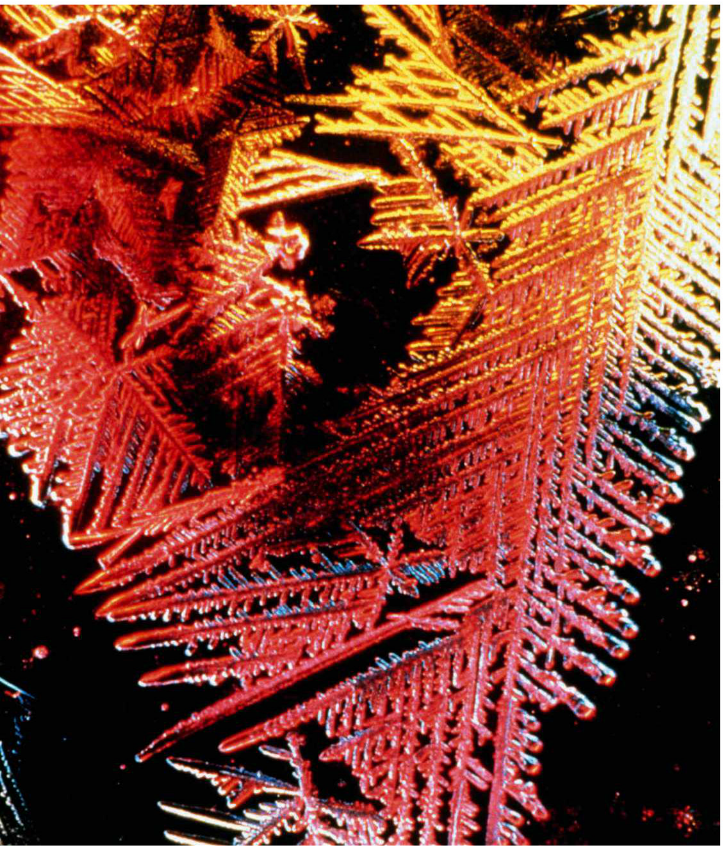
With the Utah ban now in place, Bekker estimates it could take five years before we see the full effects. In Calgary, Canada, though, the effects were seen even sooner. In 2011, the city removed fluoride from its drinking water and just three years later the dental decay of children spiked. In a single year, 32 out of every 10,000 children in Calgary were put under general anaesthesia to treat tooth decay, compared with 17 out of 10,000 in Edmonton, a city in the same province. Calgary has since voted to reinstate fluoride.

Although 63 per cent of the US population receives fluoridated water, most countries don't add fluoride to their drinking water. Reasons range from its natural occurrence in drinking water to concerns over safety and the belief that people should be able to choose what they ingest.

According to the CDC, during 2015–2018, US children and adolescents drank an average of 23 ounces (680ml) of tap water daily.

In the UK, only 10 per cent of people receive purposely fluoridated water, with fluoride occurring naturally in low levels in most drinking water in England and Wales. But the UK government confirmed in March that it would expand water fluoridation in the north-east, after data revealed that one in five children aged five has experienced tooth decay in England, with higher rates of up to one in three in more deprived areas. The most common reason children aged five to nine are admitted to hospital is to have treatment for decayed teeth.

"Recent studies have shown that the benefit of water fluoridation isn't as dramatic as it used to be, since fluoride was added to toothpaste and became more widely used from the 1970s," says Dr Andrew Bain, a dentist based in London. "But tooth decay is on the rise and we need better education around dental care. The frequency of sugar intake is key to prevention. So, I would be in support of water fluoridation here in the UK."



Dr Scott Tomar, professor and associate dean of prevention and public health sciences at the University of Illinois, Chicago, and a spokesman for the American Dental Association, applauds the UK's water fluoridation extension. He's concerned that misinformation in the US on fluoride could lead to public fear of the mineral in other forms – including toothpaste – and lead to more bans across US states and communities.

Tomar points out that the support for fluoride across the dentist community is proof of its success and safety, because it goes against the financial interest of dentists – you can make much more money treating problems than preventing them. "So why would we be championing water fluoridation like this?" he asks. "I'm very concerned because we don't have great alternatives to fluoride and we can no longer turn to the federal government for support."

Dentists and industry bodies are, instead, coming together to fight their cause, with the Utah Oral Health Coalition due to launch the Your Smile Matters campaign to promote good oral health. "We believe this is mostly a political decision," says Lorna Koci, chair of the coalition and program director of Davis Donated Dental, which supports vulnerable communities with dental care.

"We continue to believe that water fluoridation is safe – it's the most effective way to fight decay and the most cost-effective method." **SF**

by **ANA SANTI**
Ana is a journalist specialising in sustainability and climate change, and the author of Three Things to Help Heal the Planet.

CORAL-FRIENDLY SUNSCREEN

Chemicals in sunscreen can bleach and harm coral reefs, but a new product on the market hopes to replenish them

Apply at least 20 minutes before swimming. That's what the sunscreen labels say. But they rarely point out the chemicals that can wash off and harm the environment.

Back in 2008, scientists raised alarms that many of the chemical UV-filters in sunscreens are toxic to sea life. In particular, corals. Oxybenzone is a common ingredient and in lab tests it can induce coral bleaching – the potentially lethal process where stressed corals eject their symbiotic algae and turn white.

The same chemical can damage coral DNA and cause deformities in coral larvae, making them grow a hard exoskeleton before they're ready to settle onto the seabed and flourish into a colony.

Estimates of the amount of chemical sunscreen washing onto coral reefs vary between 4,000 and 14,000 tons every year, both from swimmers and via wastewater systems.

A 2015 study found that a popular tourist hotspot in the US Virgin Islands, Trunk Bay, attracts so many sunscreen-soaked swimmers, it could be preventing coral larvae from settling and harming the corals' ability to heal from wounds. Meanwhile, in a less popular location nearby, Caneel Bay, the coral reefs thrived.

Studies such as these, showing contamination in the sea more than 100 times higher than levels known to damage corals, have prompted bans on oxybenzone sunscreens in the US Virgin Islands, Bonaire, Hawaii and Palau.

Mineral sunscreens, containing nano-sized (between 1nm and 100nm, one nanometre being one-billionth of a metre) particles of UV-blocking titanium dioxide or zinc oxide, are generally offered as environmentally-friendly options. Studies have shown, however, that these can still be harmful to sea life.

When mussels were exposed to zinc oxide nanoparticles in a lab for 12 weeks, their rate of respiration increased and they grew more slowly. At higher concentrations of sunscreen, many of the mussels died.

CORAL CURE-ALL?

A new product launched in 2025 promises something no other sunscreen does. The makers of Coral Care claim it's not only non-toxic, but when it washes off it will actually feed and enhance coral growth.

The product is a collaboration between the global advertising agency, McCann, and a team of biologists at the University of Derby led by Prof Michael Sweet. Together, they came up with the idea of making sunscreen mixed with coral food, similar to the kind that's given to corals in aquariums.

Sweet's team in Derby tested the product at two doses – one similar to other lab studies of sunscreens and a lower dose matching levels of sunscreen measured in the sea. The tests were done on four coral species, measuring various metrics of coral health, including linear and vertical growth rates.

After eight weeks, PhD researcher Triona Barker found that with the addition of the new sunscreen, the corals were growing up to eight per cent faster than in normal seawater, which came as a surprise to Sweet. "We never dreamt that it would be properly positive," he said.

Barker continued the tests for 12 weeks and ended up showing as much as a 29 per cent increase in coral growth.

SEA SAFE

On average, reef-building tropical corals obtain around 80 per cent of their energy from photosynthesising symbiotic algae hosted in their bodies, and the other 20 per cent **they feed themselves. Assisting them in gaining that 20 per cent could help them stay healthy. "It's that extra boost just to keep everything in balance," says Sweet.**

Whether Coral Care will help corals grow in the wild is still an unanswered question. It would take long-term field trials to find out, for instance, persuading tourists visiting Trunk Bay to use Coral Care, then waiting to see if the wild corals begin to regrow.

Sweet hasn't done tests yet, but wonders if the nutritious sunscreen could help corals in a similar way to probiotics, which he also studies. "If you deliver probiotics to corals, they get that extra bit of thermo-tolerance," he says. "They still bleach in increasing temperatures, but they can retain their tissue composition, so they don't actually go through apoptosis, which is programmed cell death."

But as he points out, it won't stop coral reefs from succumbing to the much bigger, global threats of climate change and pollution. "It's a splash in the ocean, so to speak, as far as making a difference with the sunscreen," he says.

Alongside Coral Care, Sweet and the McCann have developed an accreditation system for ocean-friendly sunscreens – something that's badly needed.

A 2020 study showed that almost half the sunscreens on sale labelled as 'reef safe' still contain oxybenzone or other ingredients known to be reef toxic.

Called Reef Protection Factor, or RPF, the idea is that sunscreen manufacturers can send their products to be screened at accredited testing labs, including Sweet's. A sunscreen will pass if multiple lab-grown corals show no signs of stress after a set amount of time: seven days for a bronze certificate, 50 for silver and 100 days for gold.

Sweet's hope is that a government agency will take on the RPF system so it can go mainstream, helping consumers to make a more explicitly sea-safe choice.

by **DR HELEN SCALES**

Helen is a marine biologist, broadcaster and science writer.

RPF
Reef Protection Factor
Coral Care
THE WORLD'S FIRST SUNSCREEN THAT NOURISHES CORAL REEFS
Powered by
STREAM2SEA
30 SPF
UVA
UVB
ECO-SAFE MINERAL SUNSCREEN WITH A UNIQUE BLEND OF PROVEN CORAL NUTRIENTS
BROAD SPECTRUM SPF 30
WATER-RESISTANT 80 MINS
2.5 FL OZ (75 ML)

Look at the label

A long list of chemical compounds used in sunscreens, cosmetics and shampoos are known to harm sea life. Ones to look out for and avoid include:

Oxybenzone
Octinoxate
Octocrylene
Homosalate
4-methylbenzylidene camphor
3-benzylidene camphor
Benzophenone-1 and -8
Para-aminobenzoic acid (PABA)
Butylparaben
Nano-titanium dioxide
Zinc oxide

(If you can rub in sunscreen and the label doesn't explicitly say "non-nano" or "micro-sized", you should assume it's nano)

GETTY IMAGES, CORAL CARE

TECH TO TURN YOU INTO A CYBORG

A future where humans can lift incredible weights, see in the dark and fly sounds far-fetched, but actually… it's already here

by PETER RAY ALLISON

We're already familiar with the ways to artificially restore our bodies to their natural peak. Wearing prescription glasses can correct your vision, and hearing aids can mitigate against hearing loss. Now, new tech is on the way to enhance the human body and help us do more than ever before.

Users of these new technologies become an amalgamation of human and machine, augmenting their bodies to achieve things once thought impossible.

But these aren't just conceptual devices, they're emerging technologies that are – or soon will be – commercially available.

Take to the skies

Flight has long been a dream for humanity, from the Greek myth of Icarus to the flying cars in science fiction films like *Blade Runner*. But while personal flying tech may seem fanciful, it already exists today, in the form of the Gravity Jet Suit.

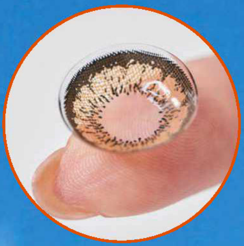
Though we once dreamed of rocket boots lifting us off the ground, these would (unfortunately) be inherently unstable. The thrust would be applied away from the wearer's centre of gravity.

Instead, the Gravity Jet Suit uses five engines to gently manoeuvre the wearer through the air. Pilots are able to hover, turn and even fly short distances over water or land. A 1,050-horsepower gas turbine on the back provides core lift, while two smaller jet turbines on each arm offer stability and control.

In 2023, the Royal Navy tested the suit in training exercises to explore its potential for ship-to-ship boarding operations.

ALAMY, GETTY IMAGES, CASE WESTERN RESERVE UNIVERSITY, DANI CLODE/UCL

See with your eyes closed



Human eyesight is relatively poor. Without light, we're effectively blind. Night vision goggles, which allow us to see infrared wavelengths of light, have been around for a while, but now this tech has been miniaturised.

Scientists in China have created contact lenses coated with nanoparticles that absorb infrared light and re-emit it as visible red, green or blue light. In tests, these lenses enabled people to see flashes generated by an infrared LED.

Strangely, the participants were able to 'see' the flashes better with their eyes shut, as the interference from visible light was blocked by their closed eyelids.

In the future, this technology could be adapted to help people with colour blindness see the colours beyond their limited visual range.

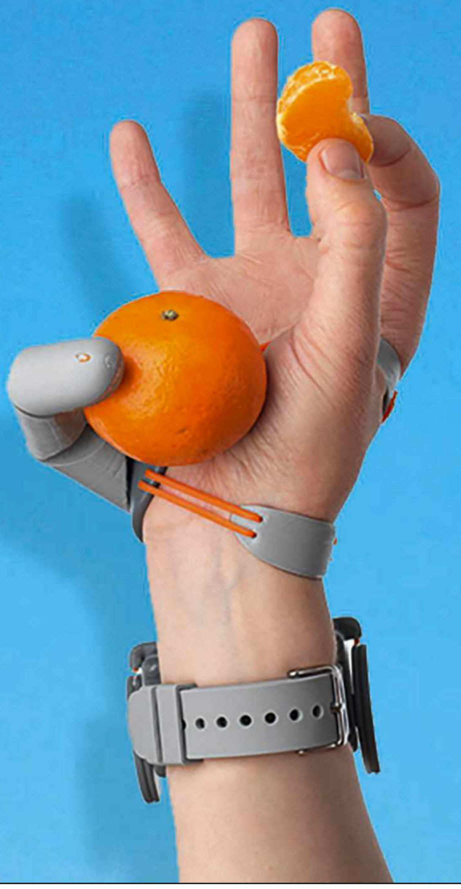
Stride towards the future

Exoskeletons are wearable machines designed to boost your natural strength. Think of them as a kind of powered suit or a wearable forklift. Though many of us associate them with the sci-fi film *Aliens*, they're already in use today.

Sensors in the exoskeleton detect your movements and activate motors in the joints to provide additional strength.

Exoskeletons have already helped some people with disabilities walk unassisted, and now they're being developed for warehouse workers to lift and move heavy loads more safely.

The tech is also finding everyday applications, such as helping people hike further or climb staircases that might otherwise be too challenging.



Get a better grip

Scientists from University College London have recently developed a glove-like device that gives the wearer an additional thumb.

This may seem redundant (most of us already have two), but trials have shown that the increased dexterity of an extra thumb allows people to complete certain tasks with one hand that normally require two.

Sensors beneath the wearer's toes control how the third thumb moves. It currently doesn't allow for haptic feedback, however, so wearers won't be using them to carry eggs just yet.

Despite a third thumb not being part of our natural anatomy, in testing, most people have quickly been able to get to grips with it – only four people out of nearly 600 were unable to use it.

Control things with your thoughts

Brain control interfaces (BCI) are an emerging field of technologies that allow people to control computers with their minds. By implanting an array of micro-electrodes into the brain, the neural signals linked to moving a limb can be interpreted by a computer to operate external devices instead.

This technology goes beyond simply improving the ability to operate a computer. It can also allow people with neurodegenerative disorders to have reliable control over their environment. So far, this tech has allowed volunteers with spinal cord injuries to control a computer cursor simply by thinking about the movement of their own paralysed hand or arm.

The next step for these devices will be to precisely control the movements of robotic limbs. With BCI technology, scientists envision a day when patients with muscle atrophy and other degenerative conditions fully regain their motor functions.

EDITOR'S PICKS...

This month's smartest tech

FRESH IDEA

If you've ever wanted to grow plants like an astronaut, then the Auk could be a fun and futuristic way to keep your kitchen stocked with fresh herbs. It's essentially a hydroponic system: seeds are planted in pots filled with ground-up coconut fibre, positioned above a water reservoir. You plug a set of nutrient capsules into the system and a smart 'chip' tells the AUK what you've planted. From there, the system takes over: regulating light, nutrients and water to give you lush, harvest-ready herbs in around four to six weeks.

Auk 1, Auk Mini
From £205, auk.com

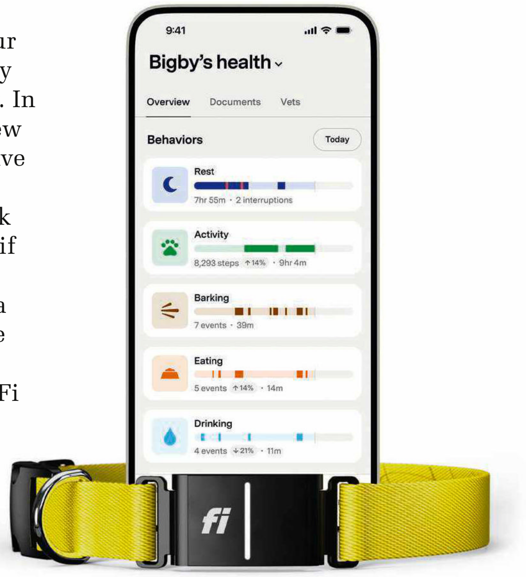
sky glass
air

↑…GLASS HALF FULL

We're big fans of Sky's Glass system, which brings together broadcast and on-demand content into an all-in-one TV that uses Wi-Fi rather than a satellite dish. The new Glass Air trims down the 7.1 speaker setup in favour of a sleeker design (though it still offers Dolby Surround Sound). It's a 4K HDR screen, powered by quantum dot LED technology with an operating system that offers voice controls. The best part? The price. You can pay for Sky Glass on top of a Sky subscription, and the base model will add just £6 a month to your bills.

Sky Glass
From £6 a month, sky.com

→…COLLAR COMPANION



Try as we might, we can't watch our beloved pets every second of the day. In recent years, a slew of pet cameras have offered us access to round-the-clock surveillance, but if you're looking to bring something a little less invasive into your home, the good folks at Fi may have the solution: a smart, stylish collar that acts like a Fitbit for your dog. Using AI, it tracks your best friend's behaviour – from appetite to barking, licking and scratching – and analyse important indicators of your dog's health. Fully waterproof with a 3-month battery life, the only thing that puts us off here is the subscription service pricing model.

Fi Series 3+
$189 (£139) annually, shop.tryfi.com

↓…GREASED LIGHTNING

This clever kit promises to convert your pedal-powered bicycle into an electric one… in just five minutes. Skarper's "disk-drive" system effectively snaps onto your rear disc brake to deliver motorised power. The company says it won't affect braking performance, as the drive system doesn't interfere with the brakes. Once installed, the unit is designed to easily unclip from your bike and slide into your bag while it's locked up outside.

Skarper
From £1,495, skarper.com

↑ …GAME ON-THE-GO

One to start saving up for, the newly announced Xbox handheld won't land until the vague "2025 Holiday" window… but it looks like it will be worth the wait. Essentially, the new system – produced through a partnership between Microsoft and Asus – is a PC you can take on the go, like the Steam Deck, but with added access to Xbox Game Pass, Epic Games and other PC libraries. Boasting a 7-inch (18cm) 1080p display with a nippy 120Hz refresh rate, it might even give the Switch 2 a run for its money come year's end.

ROG Xbox Ally X
Price TBA, xbox.com

↓…MOVEABLE MOVIE MAGIC

Take your entertainment on the go this summer with Hisense's cutest projector to date. Standing at just 23cm (9.1 in) tall, this gadget is compact enough to slip into a suitcase, making it perfect for distracting the kids at a campsite or screening the football in your mate's backyard. Setup promises to be simple, thanks to "Seamless Auto" features that ensure a clean image every time. It even includes "AI 4K Clarity technology" which uses clever algorithms to upscale images and optimise contrast for a flawless viewing experience.

Hisense M2 Pro Smart Projector
$1,299.99 (£959.08), hisense.com

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HOW TO BEAT THE AFTERNOON SLUMP

BY DAVID ROBSON

Recent research is revealing what's causing your post-lunch lethargy, why it stalls your productivity and the best ways to get your brain back into gear

It's 2pm, my eyelids are drooping and my thoughts are sluggish. I feel like I need to summon all my willpower simply to remain awake, let alone get my mind into gear for an afternoon's work. Part of me is tempted to enjoy a little siesta, but how can I justify this time away from my desk?

I haven't even eaten a large meal, just a little salad with some bread and fruit juice. Yet the post-lunch slump – known in the scientific literature as 'postprandial somnolence' – has hit me hard. It's time, undeniably, for another espresso.

Exactly what leads us to lose our energy after midday remains a matter of debate, with some research suggesting that it may be due to a natural rhythm that has very little to do with the food we eat – and respecting the brain's cadences may be far more effective than fighting them. Fortunately, this new knowledge offers some practical strategies to nudge your concentration back from its afternoon lull, as well as some tips for the perfect siesta.

THE BLUE DOT

To understand why our focus waxes and wanes throughout the day, we need to explore a tiny bundle of neurons, measuring just a few millimetres across, buried deep in the brainstem above the back of the neck.

The region is called the locus coeruleus, or 'blue dot'. It's a literal description of its appearance and a clue to its function. Cells in the locus coeruleus are the brain's primary source of a neurotransmitter called noradrenaline – the synthesis of which results in an azure pigment that gives the neurons their distinctive colour.

When it's active, the locus coeruleus delivers noradrenaline to the rest of the brain, where the neurotransmitter eases communication in the synapses between neurons. Higher levels mean that the cells are more likely to spike with electricity when they receive input from another neuron, which passes the message on to other cells within their network. This raises your arousal, so that you feel more alert to your surroundings.

Given these effects, you may imagine that pumping out ever-increasing volumes of noradrenalin would bring about more and more processing power. At moderate levels, a regular supply of the neurotransmitter does indeed help the prefrontal cortex (associated with attention control and abstract thinking) to operate more efficiently, allowing you to maintain optimum focus. Once your arousal has passed a certain peak, however, the increased cacophony of brain signals can begin to feel overwhelming and may even push you into a fight-or-flight response. A sense of mounting pressure – caused, for example, by an impending deadline – may lead the locus coeruleus to react in this way and the unfortunate result is that you struggle to think clearly.

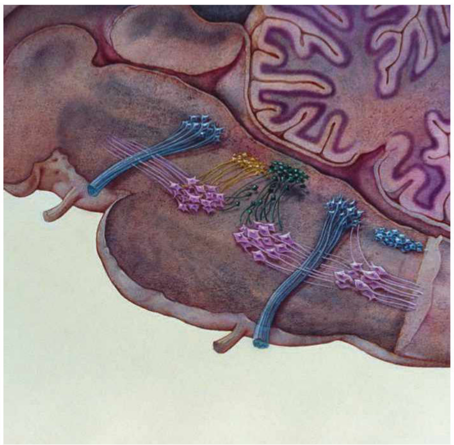
> "YOU MAY IMAGINE THAT PUMPING OUT EVER-INCREASING VOLUMES OF NORADRENALINE WOULD BRING ABOUT MORE AND MORE PROCESSING POWER"

For this reason, some researchers now argue that there's a 'Goldilocks Zone' in our noradrenalin levels that's optimum for most intellectual tasks.

In her book *Hyperefficient*, the neuroscience researcher Dr Mithu Storoni describes the locus coeruleus as the brain's gearbox. First gear (low activity) corresponds to sleepy mind-wandering; second gear (medium activity) is ideal for deep focus and concentration; and third gear (a state of high alert) helps you deal with a crisis.

The locus coeruleus's activity naturally varies over the day. It's practically silent

BELOW An illustration of a cross-section of the brain stem, showing the locus coeruleus (in green)



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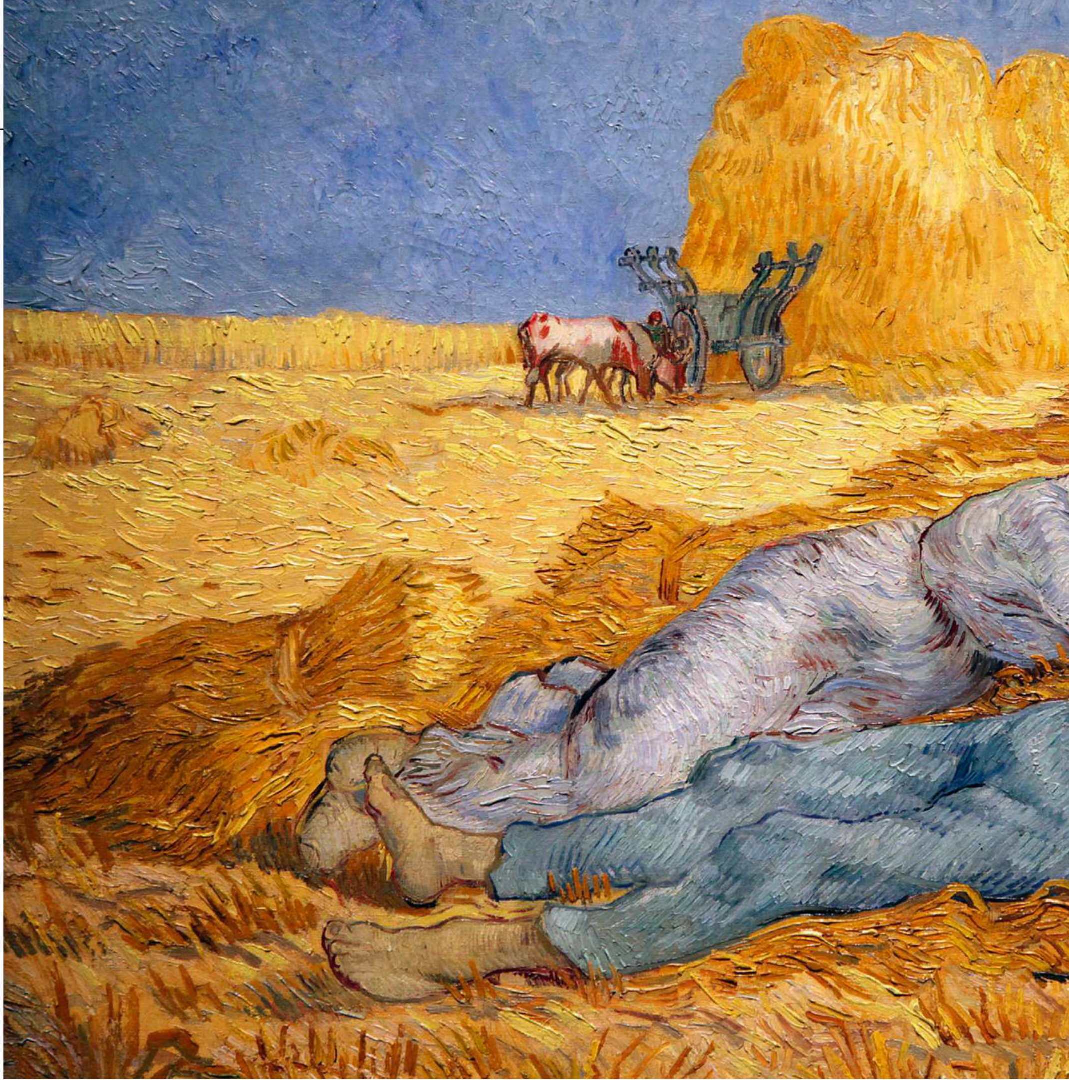

“VARIOUS STUDIES SUGGEST THAT SHORT NAPS IMPROVE OUR MOOD, AS WELL AS RESTORE OUR FOCUS”

during sleep, but becomes far busier as we wake, and its activity continues throughout the morning – leading us from first to second gear, in Storoni’s terminology.

At around lunchtime, however, it temporarily falls back into the lowest gear – a result, Storoni says, of an evolved biorhythm that would have programmed us to nap every 12 hours or so. (This is sometimes known as a ‘circasemidian rhythm’, which occurs alongside the better-known circadian rhythm that repeats every 24 hours or so.) This leads us to feel drowsy in the early afternoon, even if we haven’t consumed anything.

The trough only lasts a couple of hours, meaning that most people will regain their focus by 3pm, though the exact timing will depend on your chronotype – whether you’re a night owl or morning lark. “If you’re an owl and wake up at 10 in the morning, your dip may shift to later in the afternoon, whereas if you’re a lark who has been up since 5am, your dip may happen sooner, even before noon,” Storoni writes.

A few studies suggest that eating can deepen the trough in arousal, which impairs cognitive performance, though the precise reason why remains unclear. You may have read that carbs will make you feel sleepier, for example, but the evidence behind this idea is limited. This claim appears to arise from an experiment carried out in the early 1970s, which found that carbohydrate-rich meals raised the levels of the amino acid tryptophan in the blood. This was thought to lower our arousal, since tryptophan is used by the brain to produce the neurotransmitter serotonin and the hormone melatonin – both of which should promote sleep.

If this were true, then a large sandwich or bowl of pasta would send our energy levels temporarily plummeting. The early study was only conducted in rats, however, leading Dr William Orr at the Thomas N Lynn Institute for Healthcare Research in Oklahoma to question whether the composition of a meal makes any difference to human arousal. To find out, his team gave 10 participants high- or low-carb meals and then measured how long it took them to drop off for an afternoon nap afterwards. Surprisingly, Orr and his team failed to find a significant difference between the two groups.

ABOVE LEFT Dr Mithu Storoni

ABOVE A brief afternoon snooze – as depicted here in Van Gogh’s *The Siesta (after millet)* – appears to have benefits for our attention in the short-term, as well as our general brain health in the long term

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You may also have heard the claim that eating diverts blood from the brain to the digestive system, which leads to our foggy heads. In reality, the blood flow inside our skulls seems to be pretty constant no matter what our activity; this is for good reason, given how important it is to deliver enough oxygen to our grey matter.

We can't rule out the possibility that eating may influence our arousal through other pathways, though. The gut is directly connected to the brain through the vagal nerve, which could temporarily reduce activity in regions associated with mental focus. The brain's sleep centres may also be influenced by digestive hormones that control satiety. Scientists have yet to directly test these hypotheses, however.

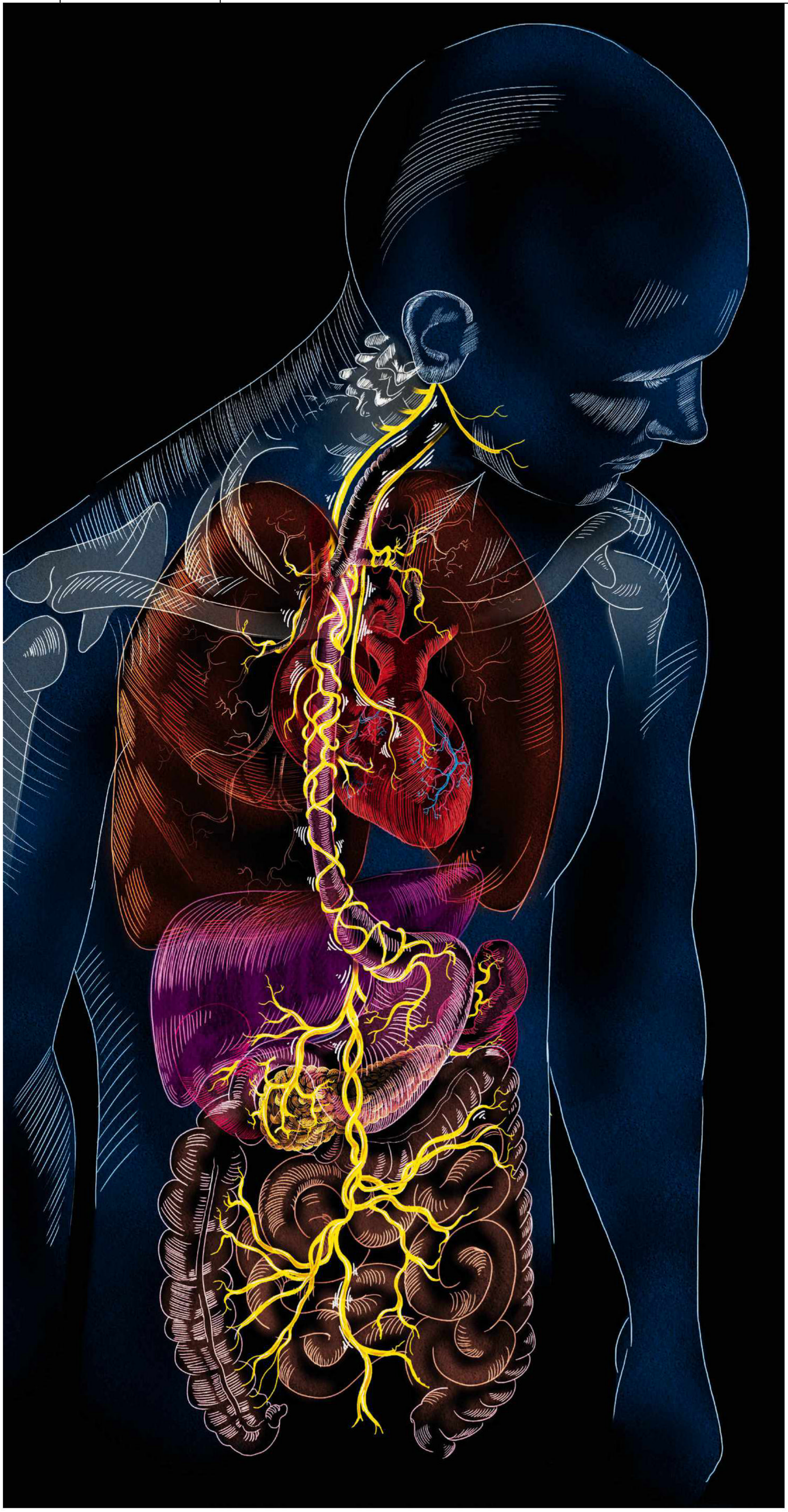
BELOW A link between eating carb-rich meals and a decline in energy levels has yet to be established

SLEEP IT OFF?

Whatever the cause of the early afternoon slump, many of us would like to learn how to ease our way through the cognitive fog it produces. The most obvious response may be to sleep it off. Accumulating evidence shows that napping can enhance our wellbeing, so why not give in to the feelings of drowsiness? On awakening, we should feel brighter than ever.

Various studies suggest that short naps can improve our mood, as well as restore our focus and concentration for cognitive tests, and they may even bring long-term benefits to our brain's health. A few years ago, Dr Vicky Garfield and colleagues at the University of Liverpool in the UK examined data from the UK's Biobank, which contains brain scans of hundreds of thousands of participants. Most brains shrink as their owners get older, but Garfield and her colleagues found that people who regularly took daytime naps (three times a week or more) kept hold of more grey matter for longer. "The effect was around 15cm^3 (almost 1in^3), which we said was equivalent to between three to six years of ageing, essentially of brain ageing," Garfield says – though she emphasises that we'll need to test the effects in other groups.

A short snooze can also enhance your physical prowess. "Daytime napping is a common strategy among athletes, particularly during periods of intense training or competition," says Omar Boukhris from La Trobe University in Melbourne, Australia. He argues that taking a short sleep can encourage activity in the parasympathetic nervous system, which is responsible for the body's resting, so that it can repair our tissues and handle life-enhancing processes like digestion. The result, Boukhris says, is reduced inflammation, "contributing to better cardiovascular regulation and overall recovery".



LEFT The vagus nerve (in yellow) provides a link between the heart, lungs, digestive tract and brain

Taking stock of the available studies in a recent meta-analysis, he found significant benefits for athletes' performances in events requiring short bursts of energy, such as sprinting. Crucially, the timing mattered. "The most beneficial naps were those taken in the early afternoon," Boukhris says, exactly when we're programmed to feel most drowsy.

All of these findings come with caveats, which include the amount of time we spend dozing. "If you nap for too long, then you go into deep sleep – you'll find it harder to wake up and then you'll be less productive for the rest of the day," Garfield argues. It leaves your brain stuck in its lowest gear. Even worse, a longer afternoon nap may prevent you from sleeping at night, meaning that you'll start the next day with an attention deficit. "It becomes a vicious cycle."

There may be many other important reasons to keep our siestas short and sweet. The body clock, after all, is intricately linked to all kinds of bodily processes and a luxuriously long afternoon nap could throw these into disarray. "Circadian misalignment can negatively impact glucose metabolism, increase appetite and fat storage, and impair autonomic regulation," says Dr Alejandro Fernandez-Montero at the University of Navarra.

Fernandez-Montero and his colleagues recently analysed data from nearly 10,000 Spanish graduates, recruited over the past 26 years, who had been asked to report how often they had a siesta each week. Six to eight years after signing up to the study, the participants were also tested for signs of metabolic syndrome, which describes a cluster of health problems associated with the body's energy intake and expenditure that are associated with type 2 diabetes and cardiovascular disease. Its components include elevated blood pressure, high blood sugar, a large waist circumference and a low level of 'good' HDL (high-density lipoprotein) cholesterol.

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Controlling for a whole host of other factors – such as diet, physical activity, working hours and stress levels – the team found that lengthy siestas, lasting more than half an hour, were associated with considerably worse markers of metabolic syndrome. The data seemed to suggest that a 15-minute siesta was better than no siesta at all, however. “The safest and most beneficial window appears to be short naps of 10–20 minutes, enough to improve alertness and cognitive function without triggering adverse metabolic effects,” Fernandez-Montero concludes.

Such findings fit with an earlier meta-analysis by Prof Tomohide Yamada at the University of Tokyo and colleagues, who crunched data from 288,883 participants across the US, Europe and Asia. They noted that regularly taking naps of more than 40 minutes increased the chances of developing diabetes, while shorter naps came with no health risks.

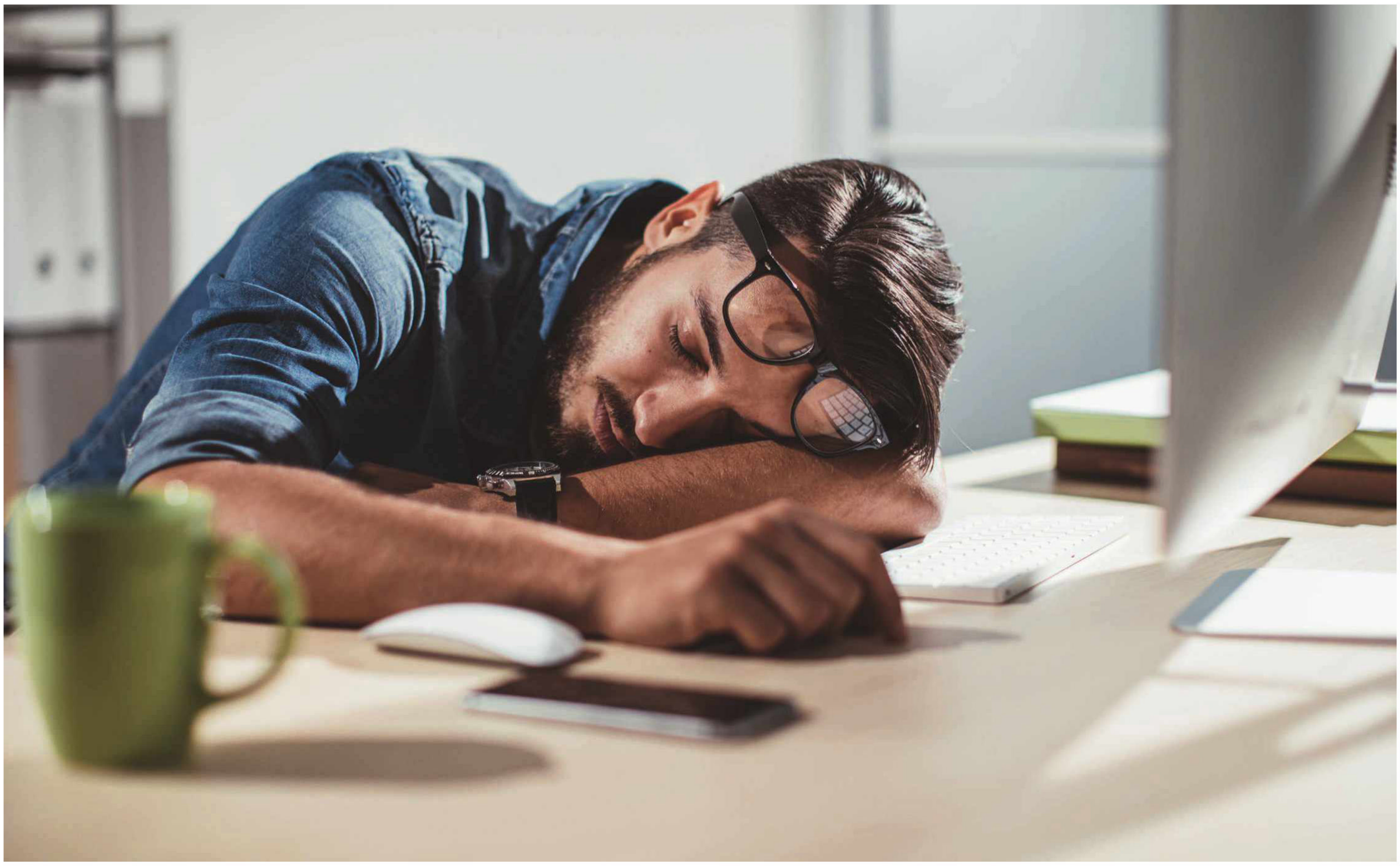
> **“THEY NOTED THAT REGULARLY TAKING NAPS OF MORE THAN 40 MINUTES INCREASED THE CHANCES OF DEVELOPING DIABETES”**

If you’ve been tempted to indulge in a lengthier snooze, try not to schedule anything intense too close after waking, since the lasting feelings of grogginess known as ‘sleep inertia’ will limit any of the benefits you might have gleaned from the time out. Instead, you should incorporate a buffer zone that allows you to return to full alertness. Boukhris noted as much in his analyses of athletic performance. “The time between the end of the nap and the exercise influenced outcomes: the longer the gap, the greater the performance benefit,” he says.

RESPECTING THE BRAIN’S RHYTHMS

If napping isn’t possible, there are many other ways to respect the brain’s rhythms. You might stop to strike a few yoga poses or take a gentle stroll around the park. “A 30-minute walk can produce cognitive benefits comparable to those of a short nap,” says Fernandez-Montero. “Light

BELOW The locus coeruleus falls back into ‘first gear’ around lunchtime, leaving us feeling drowsy in the afternoon



RIGHT Taking a break to do something active can help to perk your energy and attention back up after lunch

physical activity activates the brain and enhances mood and attention, without disrupting circadian patterns."

Garfield agrees, pointing out that any relaxing activity done away from the desk should be beneficial. "You're still resting your brain, even if you're not actually napping," she says.

At the very least, you can alter your schedule so that you avoid tackling the taxing problems while your brain is still in its lowest gear. "Schedule the most 'non-thinking', inconsequential and low-effort tasks into the post-lunch dip period to around 3pm or so," Storoni advises.

None of this should make up for bad nocturnal habits, though. "Adequate nighttime sleep remains the cornerstone of sustained daytime cognitive performance," says Fernandez-Montero.

I've taken note. Over the days that it took to research and write this piece, I've paid closer attention to my body and brain's rhythms. In the past, I'd have relied on espresso shots to power through the dips in my attention, but I've started to take more breaks away from my desk. I find that my attention soon picks up, without the jangling nerves and bad breath that follows my caffeine fix. It's also easier to unwind during the evening and I sleep better at night – leaving me recharged and refreshed to start another day. **SF**

"SCHEDULE THE MOST LOW-EFFORT TASKS INTO THE POST-LUNCH DIP PERIOD TO AROUND 3PM"

by **DAVID ROBSON**

David is an award-winning science writer and author of The Laws of Connection: 13 Social Strategies that will Transform your Life *(Canongate, 2024).*

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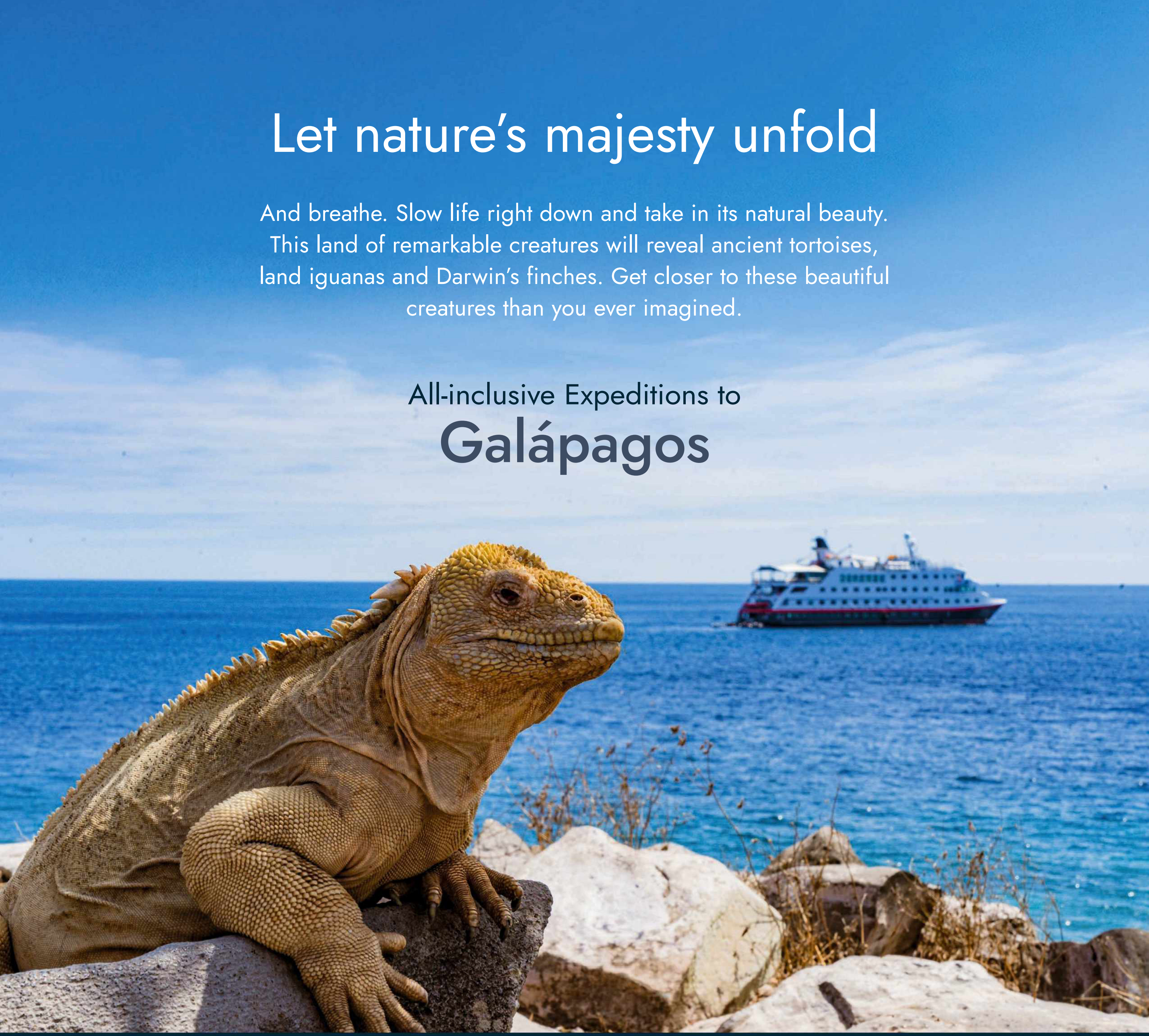

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DEFENDERS OF THE EARTH

Meet the people who keep watch for world-ending asteroids

by GEORGINA TORBET

ESA/A BAKER

You're woken in the middle of the night by an urgent phone call. An asteroid is headed straight for Earth and it's your job to find out if it'll strike the planet and rain destruction down upon us all.

It sounds like an overly-dramatic movie trailer, but that's the real-life task of the people in the European Space Agency's (ESA) Near-Earth Objects Coordination Centre, or NEOCC – a multidisciplinary centre staffed by astronomers, mathematicians and engineers who work on predicting asteroid impacts. People like Richard Moissl, Marco Fenucci and Dora Föhring (see 'Meet the asteroid hunters', p55). They're part of the dedicated team monitoring our skies to protect the planet from potential threats from above.

ON THE LOOKOUT

When it comes to defending a planet, the first step is finding out where the largest asteroids are.

"You can only do something to address a threat if you know about it," Moissl says. "So the very first step in the whole chain is observations. You need to find the asteroids."

The aim here is to identify any potential threats with as much advance warning as possible, so that there's time to take action to protect us and the planet. For example, we could launch an intervention like NASA's DART (Double Asteroid Redirection Test) mission in 2022, which saw a spacecraft deliberately crash into an asteroid to alter its course. With enough time, even a relatively small intervention such as this would be enough to deflect a very large, dangerous asteroid.

But if it helps to set your mind at ease, know that the vast majority of very large asteroids have already been located. "The kind of objects that we're really worried about are the ones that could destroy a city," Föhring says. The advantage of searching for these objects, which are over 100m (almost 330ft) across, is that they're big enough to spot easily. "These really dangerous ones, we think we've discovered 99 per cent of them."

The main focus for asteroid hunters now is medium-sized objects, which aren't big enough to destroy the entire planet, but could cause terrible harm if they landed in an inhabited area.

> "THE AIM HERE IS TO IDENTIFY ANY POTENTIAL THREATS WITH AS MUCH ADVANCE WARNING AS POSSIBLE"

Systems like ESA's upcoming Flyeye telescopes and a whole host of other ground-based observatories scan the sky, searching for the slowly moving dots that mark an asteroid. But a single observation isn't enough to know about their size or path, so follow-up observations are required. That's where the NEOCC comes in.

CHARACTERISING AN ASTEROID

Asteroids aren't easy to observe, as they're so much smaller than planets and can have a wide range of characteristics. They can be solid rock or loose piles of rubble. They're made of all kinds of materials, which can make them appear brighter or dimmer. This is a particular problem, as measuring an asteroid's brightness is one way astronomers estimate how large it is; larger objects reflect more light.

"You could have a very reflective object that appears to be much bigger, relatively, or you could have a much darker object that's actually very big, but looks like something small," says Föhring.

Because of the challenges inherent in finding these objects, astronomers work with many data sources, from automatic robotic telescopes to huge all-sky surveys.

"We want to have as many observations as we can," Föhring says, especially if an object looks like it might hit Earth soon. "It's actually more valuable to get positions from multiple locations around Earth, rather than from the same country or continent," because that gives a more accurate position determination.

"We even get in touch with people from, shall we say, less friendly countries. Because it's not about politics; it's about the science. And we all understand that comes first."

A CLOUD OF ORBITS

When the astronomers have observed as much information as they can, that's when the mathematicians step in.

"We get everything that the astronomers measure about asteroids and their positions in the sky, and from there we try to reconstruct their 3D orbits in the Solar System," Fenucci says. But that isn't simple either, as there are many uncertainties in the data, and often there is more than one potential orbit that fits the data, creating "a cloud of possible orbits that are compatible with the measurements."

It's all a matter of probability to take these possible paths and see how many could cross Earth's. And it's done using a program called Aegis. The software lets the team see if anything is predicted to pass close to Earth in the coming decades and the information is shared on a risk list of current most-threatening objects.

As well as information on these further-off potential impacts, there's also a system for identifying small objects predicted to strike Earth imminently. While that sounds scary, there are actually millions of small asteroids in the Solar System, many whipping past Earth on a regular basis. Most that enter our atmosphere burn up harmlessly before reaching the ground. Still, studying these objects – and the ones that do impact Earth – is valuable for research and to practice dealing with more dangerous events.

The imminent impactor alert system is called Meerkat, Moissl explains, "named after the little mongoose guys, as there's always one on the lookout to tell the others that something is coming." Typically, an imminent impact is spotted a few times per year, with around two to twelve hours of warning.

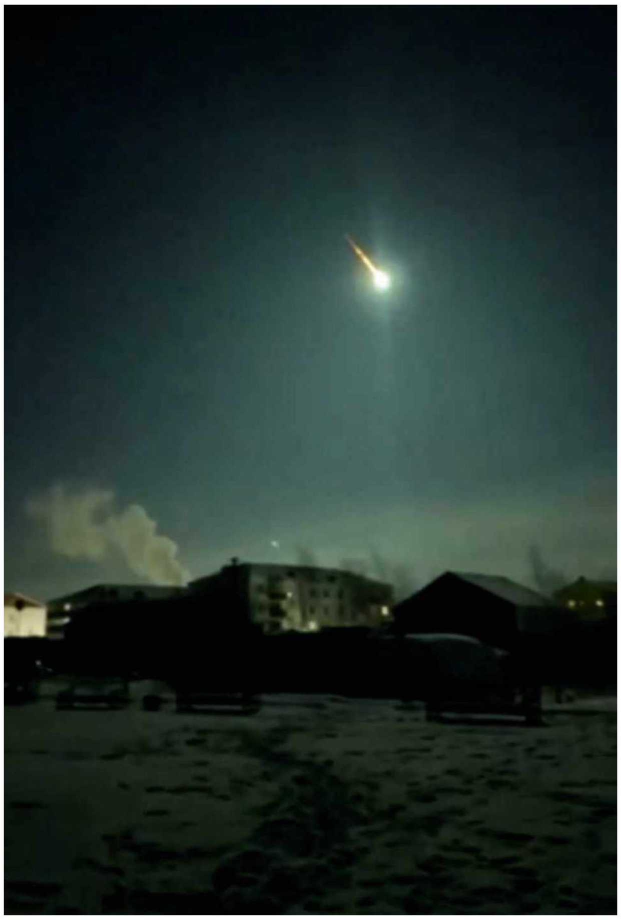
"It's like high-speed training," says Moissl. "Everything happens in a matter of hours."

ALERTS NIGHT AND DAY

As working on near-Earth objects requires such varied areas of expertise, the NEOCC office is full of researchers from a wide range of fields.

"It's a unique environment because you're putting astronomers and mathematicians together in the same office, and we can interact with each other to tell each other what interesting cases we have," says Fenucci.

> "PEOPLE WHO GET THE WAKE-UP CALLS ARE VERY EXCITED TO GET THEM. THEY LIVE FOR THAT"



ABOVE Richard Moissl (holding a piece of a meteorite) is the head of ESA's Planetary Defence Office

FAR LEFT It might look like any regular office, but from here, the staff at the NEOCC keep watch for any astronomical objects that may pose a threat to Earth

LEFT The asteroid that hit Lensk, Russia, in December 2024 first popped up on the NEOCC's quick-alert system during the team's Christmas party

ESA/J MAI, SAKHA REPUBLIC MINISTRY OF INTERNAL AFFAIRS, ESA/NEOCC

The physical proximity makes for a highly collaborative environment and the team pulls together whenever an urgent event arises. One example being the time they all scrambled to help one member find information on 1979 XB, a huge asteroid with a poorly understood orbit, which popped up after not being seen for 40 years.

There are some differences between astronomy work and other office jobs, though. "Observations are at night, so we don't do that from the office normally. We often schedule things or observe from home," Föhring says. Asteroids have no respect for the nine-to-five schedule, so the team has to be flexible about their work times. "When we have an impact alert, it's not guaranteed to be at 9am in the morning so we have all day to work on it!"

In practice, these alerts rarely come at convenient times. "The imminent impactors have a bias towards weekend nights," Moissl jokes.

Though workers at the centre can choose whether or not to receive these notifications, and people often take evenings off for special events, generally speaking, they're thrilled to get the call as it means the opportunity for more science and learning.

"People who get the wake-up calls are very excited to get them," Föhring says. "They live for that!"

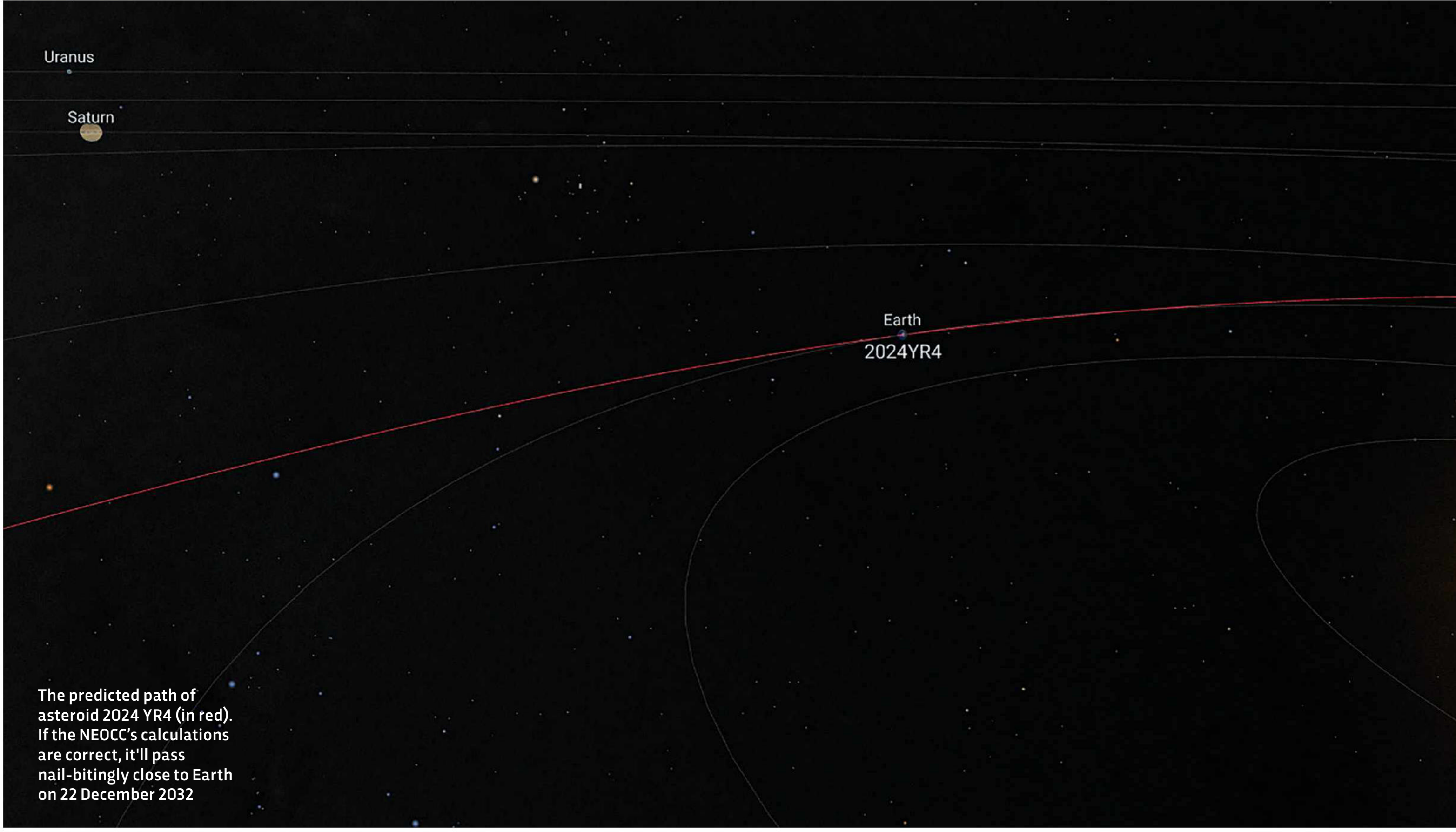
A CHRISTMAS SURPRISE

A lot of the time, working in planetary defence is much like any other office job: Zoom meetings, number crunching, dealing with emails. But occasionally, there are dramatic moments that come right out of a Hollywood movie.

Just such a moment occurred one day in December 2024 when the Meerkat quick-alert system flagged up a small impactor set to arrive imminently. This wasn't during a regular day at NEOCC, though: it was during the office Christmas party and people had come from all over Europe to celebrate with their colleagues.

Everyone was in the office and they rushed into action with observers scheduling last-minute time on telescopes and mathematicians narrowing down the impact area. Föhring was able to connect with locals in the region via a webchat to let them know a non-threatening, but noticeable impact was coming and inform them of what to expect.

The team even found a public webcam with a live feed of the area where the impact was expected in Lensk, Russia, showing a



The predicted path of asteroid 2024 YR4 (in red). If the NEOCC's calculations are correct, it'll pass nail-bitingly close to Earth on 22 December 2032

"THE TIMER WAS COUNTING DOWN TO TELLING THE WORLD ABOUT THIS POTENTIAL HAZARD"

town square next to the frozen river, with a Christmas tree on display. It gave the whole event "a very Christmassy feeling," Moissl says. The team watched together as the asteroid harmlessly came down 10 hours after the first observation. "It was an amazing day."

A CLOSE CALL

Sometimes, though, the surprises aren't so jolly. Last summer, there was an unnerving close call when automated systems reported a large object potentially more than 50m (almost 165ft) in size and with a one-percent impact probability. Worst of all, there was a ticking clock, as the potential impact was predicted to occur in just 40 days' time.

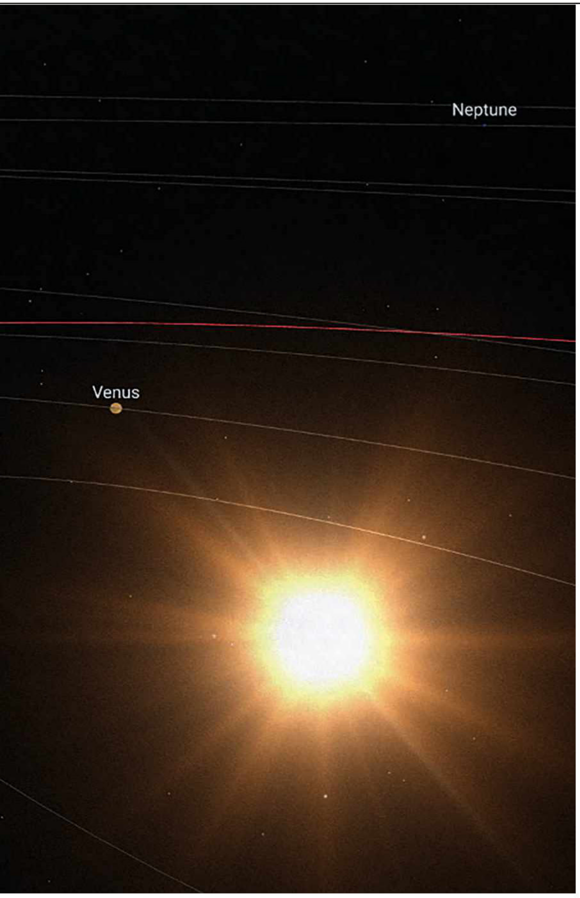
An object that large, arriving that soon, is the nightmare scenario because there's no way to launch any kind of space-based intervention in the available time. But, at least to begin with, the team wasn't that worried as an automated system flagging up a potential impact isn't that rare.

"These things happen sometimes – it's usually false alerts," Moissl says. So the typical procedure is to put more telescopes on it and assume that, as more observations come in, the impact probability will drop.

But the impact probability didn't drop. In fact, it kept rising throughout the day, reaching as high as 10 per cent. People dropped everything and rushed to find out more while working with NASA's Planetary Defense Coordination Office. As the probability continued to climb, they considered that they may soon have to issue an alert that an impact was on its way.

"The timer was counting down to telling the world about this potential hazard," Moissl says.

Fortunately, before anything was announced or a panic could begin, a key person called in. Their job was to check automated warnings against known man-made objects in orbit and they had been away from their messages while driving home from vacation.



While performing a flyby of Earth, during which this shot was taken, ESA's JUICE spacecraft was initially mistaken for an asteroid on a collision course

ESA/JUICE, ESA/ESO

MEET THE ASTEROID HUNTERS

RICHARD MOISSL is the Head of the European Space Agency's (ESA) Planetary Defence Office and oversees the efforts of Near-Earth Object Coordination Centre (NEOCC). Previously, he was part of ESA's Hera mission, which launched a spacecraft in October 2024 to investigate the effectiveness of asteroid **deflection tests.**

DORA FÖHRING is an astronomer who works on follow-up observations of newly-discovered asteroids. She is also working on the commissioning of ESA's new survey telescope, Flyeye, as part of her role at NEOCC.

MARCO FENUCCI is a mathematician who works on calculating the orbits of observed asteroids. He's a near-Earth object dynamicist at the NEOCC, so he takes data from the astronomers and uses it to model orbits and predict where the asteroids will be in future.

They took one look at the data and set everyone's mind at ease – the object wasn't an asteroid at all, but ESA's JUICE spacecraft. Having performed some complex manoeuvres, JUICE was now heading back towards Earth to perform a flyby, as planned, and would certainly not be crashing into the planet.

"That was really exciting," Moissl says.

STRESSES BOTH COSMIC AND EARTHLY

You might assume that protecting Earth from fireballs falling from space is a terrifying job, but the scientists at NEOCC don't see it that way. "Luckily, so far, we haven't had a majorly disastrous object," Föhring says.

They take their responsibility seriously, though, because even potential impacts that are years away can have real-world effects on people right now. The asteroid 2024 YR4, which will make a close pass of the Earth in 2032, made headlines this year when it was discovered to have an impact probability that went as high as 1 in 32. If the NEOCC team couldn't pin down its trajectory before 2024 YR4 went out of observation range, the world would have to wait until its next close pass in 2028 to find out whether the asteroid would hit Earth. And if it did, where?

Moissl struggles to imagine what it must be like to live in one of the cities that could be in the asteroid's path, not knowing whether it'll be wiped out in the next decade. The worry is real, as is the economic impact and social upheaval for the people considering leaving their homes. Being able to mitigate that gives Moissl a sense of purpose. "For me, that's the best part about our work."

If anything, it's the Earthly matters that feel more demanding than the cosmic ones. When 2024 YR4 was in the news, NEOCC team members were frequently being called by the media for comment – while they were trying to work out the asteroid's likely course.

"It was stressful sometimes," Fenucci admits, while Moissl says it required mental resilience to handle the attention of an anxious public while also calculating asteroid trajectories.

But that same pressure is part of what makes people in this field excel. When a new urgent target is identified, "there's a level of excitement," Moissl says. "It's very intense – there's a lot of work in a very compressed amount of time."

When the fate of the planet is at stake, doing a good day's work is an incomparable reward. Having spent weeks working on the 2024 YR4 data, the team was finally able to confirm that the asteroid wouldn't be impacting Earth after all, just before it slipped out of observation range.

"We got the confirmation from the system that the impact probability was sinking below one per cent," Moissl says. Even though the team was making jokes about the fun part of their job now being over; the relief was palpable. "That was the most joyous moment."

Though the threat of 2024 YR4 has passed, it's only a matter of time before another asteroid comes along to threaten the planet. Fortunately for us though, the team at NEOCC, along with similar organisations around the world, are keeping a watchful eye on the sky to provide the early warning we need to take the necessary action. **SF**

by **GEORGINA TORBET**

Georgina is a freelance science and technology writer, who specialises in space exploration and cosmology. She also has a PhD in psychology.

WE NEED TO TALK ABOUT INTRUSIVE THOUGHTS AND HOW TO HANDLE THEM

Disturbing ideas occur to all of us. But what happens if you're struggling to let those thoughts go?

by JAMES LLOYD

Have you ever been unsettled by an odd, scary or ridiculous thought? One that popped into your head out of nowhere and stopped you in your tracks?

Perhaps you were walking across a bridge and felt a sudden urge to hurl yourself off it. Or you were in a busy town centre and wondered what would happen if you took all your clothes off. I've worried that I have a multitude of deadly diseases, that I might stab someone I love, or that I might be evil.

The truth is, most of us get unwanted, intrusive thoughts like these from time to time, but they're not always easy to talk about. They can feel frightening and distressing, especially if we're unable to let them go. It's perhaps no surprise that an excessive amount of intrusive thoughts is associated with a whole host of mental health conditions – in my case, obsessive-compulsive disorder (OCD).

But as unsettling as intrusive thoughts may be, we are starting to talk about them more – a quick search on TikTok reveals hundreds of videos of people disclosing their deepest, darkest ruminations. Meanwhile, a growing body of research is shedding light on why we get these thoughts, what's going on in our brains when we do and how we can deal with them – offering hope to all those who struggle with them.

BEING HUMAN

Broadly speaking, an intrusive thought is any sudden thought that pops into your mind. They can be positive, such as a happy childhood memory, but it's the unwanted ones that tend to cause issues. We might also have intrusive images, urges, doubts or physical sensations.

> "TO EXPERIENCE INTRUSIVE THOUGHTS IS TO BE HUMAN, IT SEEMS"

To experience intrusive thoughts is to be human, it seems. An influential 1993 study asked around 300 university students in Canada to rate how often they had specific intrusive thoughts. All but three of the participants reported experiencing at least one intrusive thought, ranging from swerving a car into traffic (54 per cent of participants) to hurting a family member (44 per cent) to having sex with an "unacceptable person" (52 per cent). None of the participants had a diagnosed mental health condition, suggesting that these thoughts are commonplace.

Intrusive thoughts are also a worldwide phenomenon. A 2014 study led by Canadian psychologist Prof Adam Radomsky interviewed around 800 university students in 13 countries across six continents, finding that 94 per cent of participants had experienced at least one intrusive thought in the previous three months.

"It's likely that we all have intrusive thoughts," says Radomsky, who leads

ILLUSTRATION: SAM FALCONER

the Anxiety and OCD Laboratory at Concordia University in Montreal. “Those who say otherwise probably either don’t want to admit it or aren’t aware that what they’ve experienced is an intrusive thought.”

Intrusive thoughts can take any theme, but are often ‘ego-dystonic’ – in conflict with our sense of self. Common topics include harm/violence, contamination, illness, religion/blasphemy, sex, public embarrassment and self-doubt. They often attach themselves to the things we hold dearest.

“Virtually all mothers have thoughts about their baby coming to accidental harm,” says Dr Fiona Challacombe, a perinatal mental health expert at the Oxford Health Specialist Psychological Intervention Centre. “Around half of mothers also have intrusive thoughts about deliberately harming their baby.”

It can be reassuring for those who experience such thoughts to know that they don’t pose any risk. “Parents who get these thoughts don’t act on them,” says Challacombe. “They desperately don’t want something bad to happen to their baby.”

The same is true in the broader sense. “I know of no cases of anyone with intrusive thoughts acting on them,” says Radomsky. “It just doesn’t happen.”

INTO THE STORM

So if there’s nothing unusual or dangerous about intrusive thoughts, how do they become a problem? It’s all down to how we react to them.

Imagine you’re outside on a sunny day, gazing up at the sky, clouds floating by. Then, suddenly, you have an intrusive thought. Most people would just let the thought go, like a cloud on the breeze. But if the thought felt particularly weird or scary, it might be difficult to forget. You might begin to wonder what it says about you. How could anyone think something so horrible?

Quickly, the thoughts start to pile up like thunderclouds and before long, your mind is a swirling storm.

This way of thinking is common with people, like myself, who suffer from OCD. We experience repetitive intrusive thoughts (the obsessive part), which we try to counter through compulsions. The compulsions might be obvious (such as washing hands, checking lights or hoarding) or they might be more covert (such as counting, trying to neutralise thoughts or avoiding certain situations). But it’s a vicious cycle: the compulsions only alleviate the anxiety for so long, before the thoughts come back stronger and harder to counter than ever.

Intrusive thoughts are a feature of many other mental health conditions, too. People with post-traumatic stress disorder (PTSD), for example, often experience intrusive thoughts, memories or images related to their trauma, while there’s evidence that people with depression, generalised anxiety disorder and attention deficit hyperactivity disorder (ADHD) are also more prone to intrusive thoughts. These thoughts can also be a feature of addiction (often experienced as cravings) and eating disorders.

> “INTRUSIVE THOUGHTS CAN TAKE ANY THEME, BUT ARE OFTEN ‘EGO-DYSTONIC’ – IN CONFLICT WITH OUR SENSE OF SELF”

ILLUSTRATION: SAM FALCONER

"Given how common intrusive thoughts are in the general population, I would be surprised if they weren't involved in lots of conditions," says Challacombe, who notes that there are many overlaps between the conditions, and people can have more than one diagnosis.

JUST A THOUGHT?

At their worst, intrusive thoughts are torture. I used to get images of pulling off my head in order to stop the constant noise. But they're also a universal human trait, which begs the question: could there be an underlying explanation for them?

One theory is they're a side-effect of our brains' creative, problem-solving abilities. When we're faced with a new, uncertain or daunting situation, our brains will come up with a range of solutions – some of them more useful than others. Given the sheer range of possible thoughts, there's a good chance that we'll sometimes think about what we want to do (delivering a great presentation, for example), and we'll think about doing the very opposite (dancing naked in front of our work colleagues, say).

HOW TO DEAL WITH INTRUSIVE THOUGHTS

Psychologists' tips for how to handle thoughts that may be causing you anxiety

RECOGNISE THE THOUGHT

If you're feeling unsettled by a thought, label it as intrusive. Remember: everyone gets them. You might feel like the only person in the world who has had that particular thought, but someone will have had it before.

DON'T PUSH IT AWAY

Try not to fight or counteract the thought. Instead, observe the thought and let it go. Think of your thoughts as trains: let the train go past the platform, you don't need to get on it. It might feel uncomfortable not to react to the thought, but the feeling will subside.

DON'T JUDGE YOURSELF

You're not your thoughts. Many people mistakenly believe that thinking something is as bad as doing it (psychologists call this 'thought-action fusion'). Show yourself compassion and remind yourself that your values and goals are what define you. Try to resist the urge to figure out what the thought 'means'.

REFOCUS YOUR ATTENTION

Relaxation techniques, such as mindfulness and meditation, can help to soothe your mind and engage your body. Contrary to popular belief, meditation isn't about getting rid of thoughts, but learning how to be at ease with them. You could also try deep-breathing techniques or progressive muscle relaxation, but any sort of physical exercise and maintaining a regular sleep schedule can help.

SEEK HELP IF YOU'RE STRUGGLING

If your intrusive thoughts are causing you anxiety and interfering with your daily activities, reach out to your doctor or a therapist for help. The OCD-UK charity's website has a 'GP icebreaker' (ocduk.org/gp-ice-breaker) for anyone who's struggling to talk about their thoughts. Ask for access to cognitive behavioural therapy, the standard treatment for anxiety issues related to intrusive thoughts.

Certain types of intrusive thoughts might also be the brain's reaction to risk or danger, as with mothers who experience thoughts about harming their babies.

“The brain will flash an image of something that could go wrong,” says Challacombe. “Perhaps this is evolution's way of prodding us to be careful.” But these thoughts can be alarming and easily misinterpreted.

There are multiple factors that can affect how we react to intrusive thoughts, ranging from our beliefs and values to the way we experience anxiety, the vividness of our imaginations and our emotional state. Ultimately, though, our responses to them boil down to whether or not we assign meaning to the thoughts.

“Those who believe that their intrusive thoughts are meaningful are more likely to be troubled by them and have more of them,” says Radomsky. “By paying attention to the thoughts, you make them more important.”

THOUGHT SUPPRESSION

Researchers are gaining insights into unwanted thoughts by looking at the brain in real time.

“Our brains prevent us from carrying out unwanted physical actions – we need that to survive,” says Prof Michael Anderson, who leads the University of Cambridge's Memory Control Lab. “We've found that a similar process stops unwanted thoughts and memories.”

Anderson's research, summarised in a 2025 article in *Nature Reviews Neuroscience*, typically involves participants carrying out thought suppression tasks while having their brains scanned. For example, the participants might first be asked to memorise a series of word pairs, such as moss/north and honey/pencil. Then, they would be shown individual words (‘moss’, for example) and asked either to recall the associated word (‘north’) or try not to think about it.

Anderson and colleagues used this same technique back in 2017 to identify the brain process involved in stopping unwanted thoughts. The thought-stopping signals go from the prefrontal cortex (the brain's ‘command

INTRUSIVE OR IMPULSIVE?

How do you know if the unsettling thought you're having is intrusive? The internet memes about intrusive thoughts typically focus on “letting intrusive thoughts win” and feature videos of people acting on some of the quirky ideas that have sprung into their minds, such as licking their coconut-scented body butter or smashing an egg on the floor while cooking. But most of these are impulsive thoughts: the urge to act hastily without considering the consequences. Impulsive thoughts often feel exciting, whereas intrusive thoughts trigger anxiety. People don't act on their intrusive thoughts. If you're feeling worried about a thought, it's probably an intrusive one. If your thoughts are causing anxiety, you can find information, help and support at anxietyuk.org.uk and mind.org.uk

> “REGARDLESS OF HOW WELL OUR BRAINS HANDLE INTRUSIVE THOUGHTS, IT'S A FACT THAT WE ALL EXPERIENCE THEM”

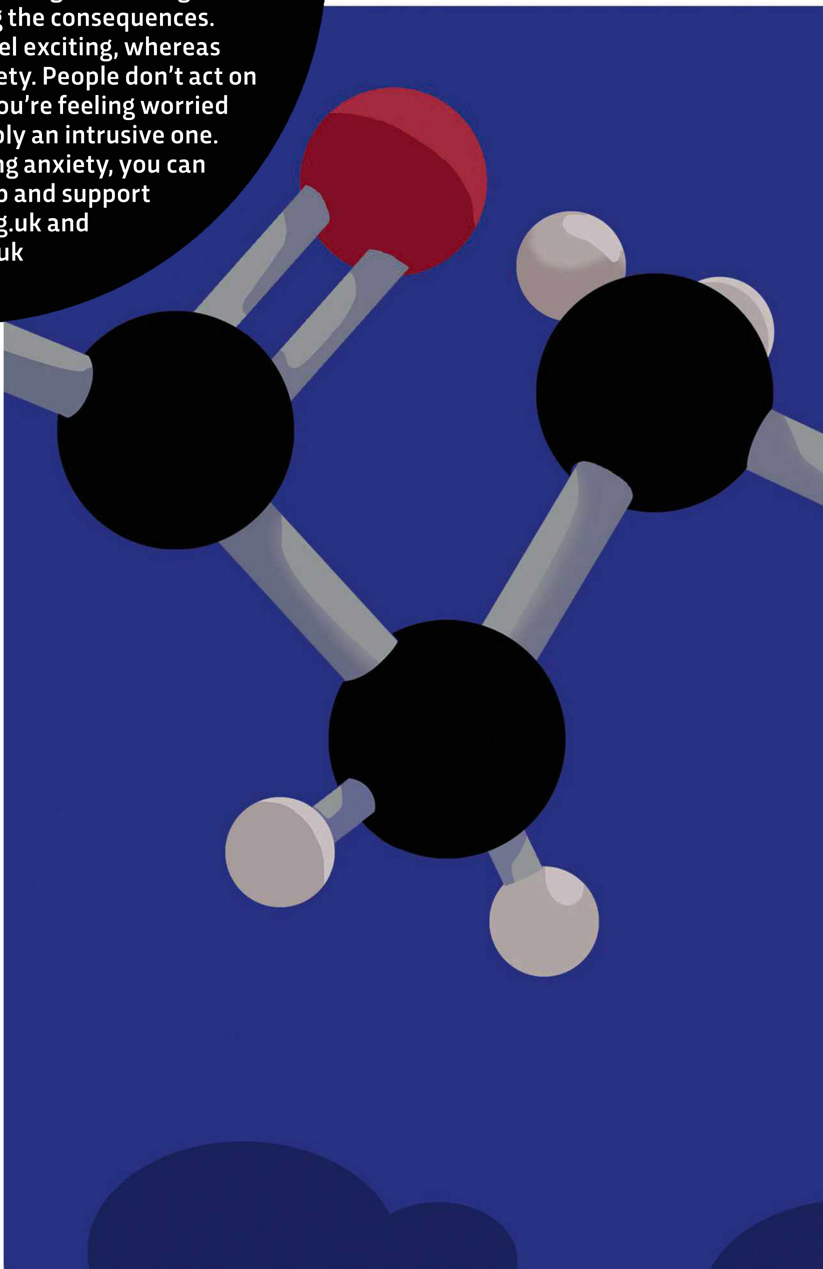
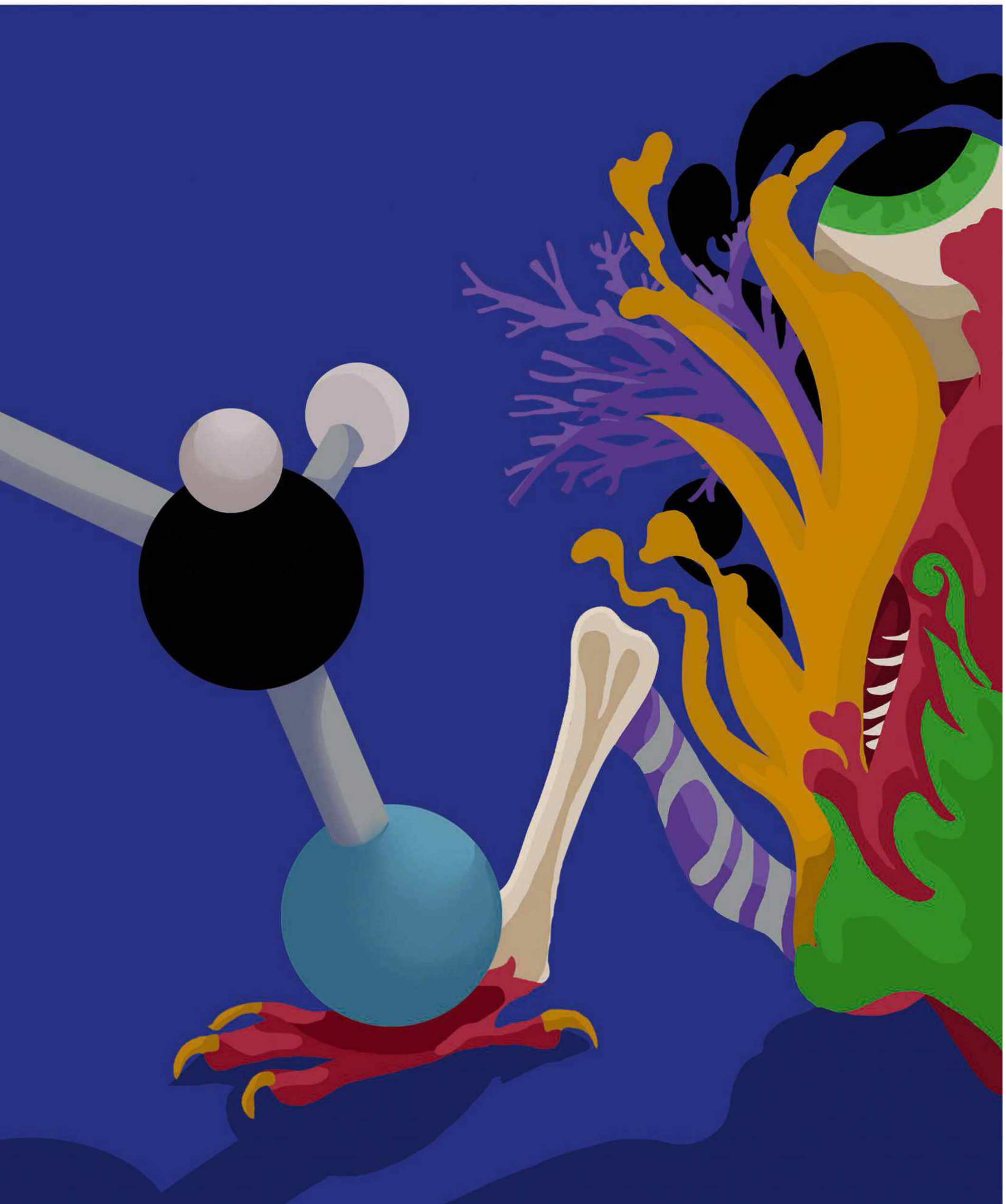


ILLUSTRATION: SAM FALCONER

centre') to the hippocampus (key to memory and learning). Crucially, participants' ability to block thoughts depended on the amount of a neurotransmitter (a chemical that allows brain cells to communicate) in their hippocampus. People with less of this neurotransmitter, called gamma-aminobutyric acid (GABA), had increased hippocampus activity and fared worse at suppressing unwanted thoughts.

Anderson believes that, by keeping a lid on unwanted thoughts, this brain process helps us to regulate our emotions. It could also help to explain what's happening in conditions associated with excessive intrusive thoughts. "This hyperactivity in the hippocampus is also seen in brain scans of people with PTSD, anxiety and depression," he says.

He hopes that this work could lead to drugs that target GABA activity in the hippocampus to improve the brain's ability to deal with unwanted thoughts. In the meantime, a 2025 study by Anderson and colleagues suggests another potential way to strengthen this brain process: it works most effectively in those who have had a good night's sleep.



A NEW LIGHT

Regardless of how well our brains handle intrusive thoughts, it's a fact that we all experience them. But we can increase our resilience to their effects by learning how best to react to them (see 'How to deal with intrusive thoughts', p59).

For those with excessive intrusive thoughts, the go-to treatment is cognitive behavioural therapy (CBT), sometimes alongside certain antidepressants.

The cognitive side of CBT involves the patient working with a therapist to reframe their intrusive thoughts, usually by coming up with two theories for what they're experiencing. For a patient who has distressing thoughts about running over pedestrians, for example, these might be: a) "I'm a dangerous person who presents a risk to society" or b) "I'm petrified of hitting a pedestrian and have misinterpreted my thoughts." The idea is to help the patient weigh up the evidence for each theory and see their thoughts in a new light.

The behavioural aspect of the therapy then involves putting this new perspective into practice in the real world, often using tasks where the patient is gradually exposed to their fears and helped to sit with the anxiety without performing compulsions. The aim is to weaken the link between the thoughts and the anxiety. The patient who worries about running someone over might be asked to read news articles about hit-and-run incidents, then write a short story in which they act out their thoughts, before driving through a town centre at the busiest time of day.

"We want to test out these fears until the intrusive thoughts are no longer calling the shots," says Challacombe.

It's about not only showing that the thoughts are ultimately meaningless, but also that full certainty is never possible. Yes, something terrible might happen, but it's highly unlikely. And that's good enough.

I still get intrusive thoughts every day, but now I know how to calm the storm. There will be many people out there suffering in silence. Hopefully, by talking more about our deepest fears, we can help them to feel less alone. **SF**

by **JAMES LLOYD**

James is a science writer based in Bristol, UK.

CHILL OUT EARTH

Geoengineering has long been a taboo subject in scientific circles. But as Earth's climate continues to warm, experts are increasingly wondering if we could, and should, take more drastic action and start tinkering with the planet in the hope of saving it

by JONATHAN O'CALLAGHAN

Human life is facing one of the biggest challenges in its history. Rampant climate change, driven by industrial activity, threatens our entire civilisation. The destabilised currents, intensifying heat waves and increasingly frequent storms are a danger to all of us.

The undisputed solution is to reduce our emissions, which may have already passed their peak, although the rate of fall isn't enough to avert the effects of a changing climate. Yet there might be another approach to complement our sluggish efforts at emission reduction. What if, as well as decarbonising our society, we used temporary measures to alter Earth's climate and prevent some of the worst effects of climate change?

That's the dream touted by those championing geoengineering, a term that refers to manipulating the environment to counteract human-caused climate change. It's not a term that has always sat well with scientists. "Geoengineering has been pretty taboo for a long time," says Jessica Wan, a climate scientist at the Scripps Institution of Oceanography in the US. "It's typically been seen as a way to deter mitigation efforts to cut emissions."

> "GEOENGINEERING IS NOT A TERM THAT HAS ALWAYS SAT WELL WITH SCIENTISTS"

Momentum, however, appears to be shifting. In May, the UK government's Advanced Research and Invention Agency (ARIA), designed to fund high-risk and high-reward research, announced £56.8 million (almost $77m) in funding for 21 geoengineering projects over the next five years in a programme called Exploring Climate Cooling. It followed a handful of other experiments in the US and Australia to investigate whether any geoengineering ideas might be viable.

"It's important to conduct small-scale research," says Michael Gerrard, a professor of environmental and energy law at Columbia Law School in the US. So, what might the future hold and could a large-scale geoengineering project ever become a reality?

BRIGHTER CLOUDS

Various techniques fall under the umbrella of geoengineering. Perhaps the most well-known and

ILLUSTRATION: SCOTT BALMER

least disputed is carbon dioxide removal. The idea is to remove CO_2 directly from the atmosphere to help reduce its impact on global warming. Work to develop such systems is already underway.

"Most climate analysts agree that CO_2 removal is absolutely necessary at large scale," says Gerrard. "There's no way we can achieve our temperature objectives unless we remove enormous amounts of the CO_2 that's now in the atmosphere, in addition to producing much less of it."

The projects being funded by ARIA and investigated elsewhere are more experimental. But due to the unease surrounding geoengineering, very little research has been carried out. There is, however, increasing demand for cautious, small-scale experiments to explore these techniques.

Undertaking research like this, transparently and openly, and releasing the findings could prevent any countries or companies attempting to try a technique themselves, without knowing what the effects could be. "There's a need for a responsible actor to operate objectively, and in the public good in this space," says Prof Mark Symes at the University of Glasgow in the UK, who leads ARIA's Exploring Climate Cooling programme.

One technique is called marine cloud brightening (MCB). As temperatures on Earth increase due to climate change, they pose a major problem to the oceans, in particular coral reefs. Hotter temperatures and overexposure to sunlight can trigger coral bleaching, where the coral expels the algae it needs for food and becomes transparent, risking disease and starvation. There are entire ocean ecosystems that rely on coral reefs to survive, so it can have devastating knock-on effects.

The effects of bleaching could be lessened with MCB. By brightening clouds above coral reefs during periods of hot weather, more sunlight could be reflected back into space, protecting the coral below.

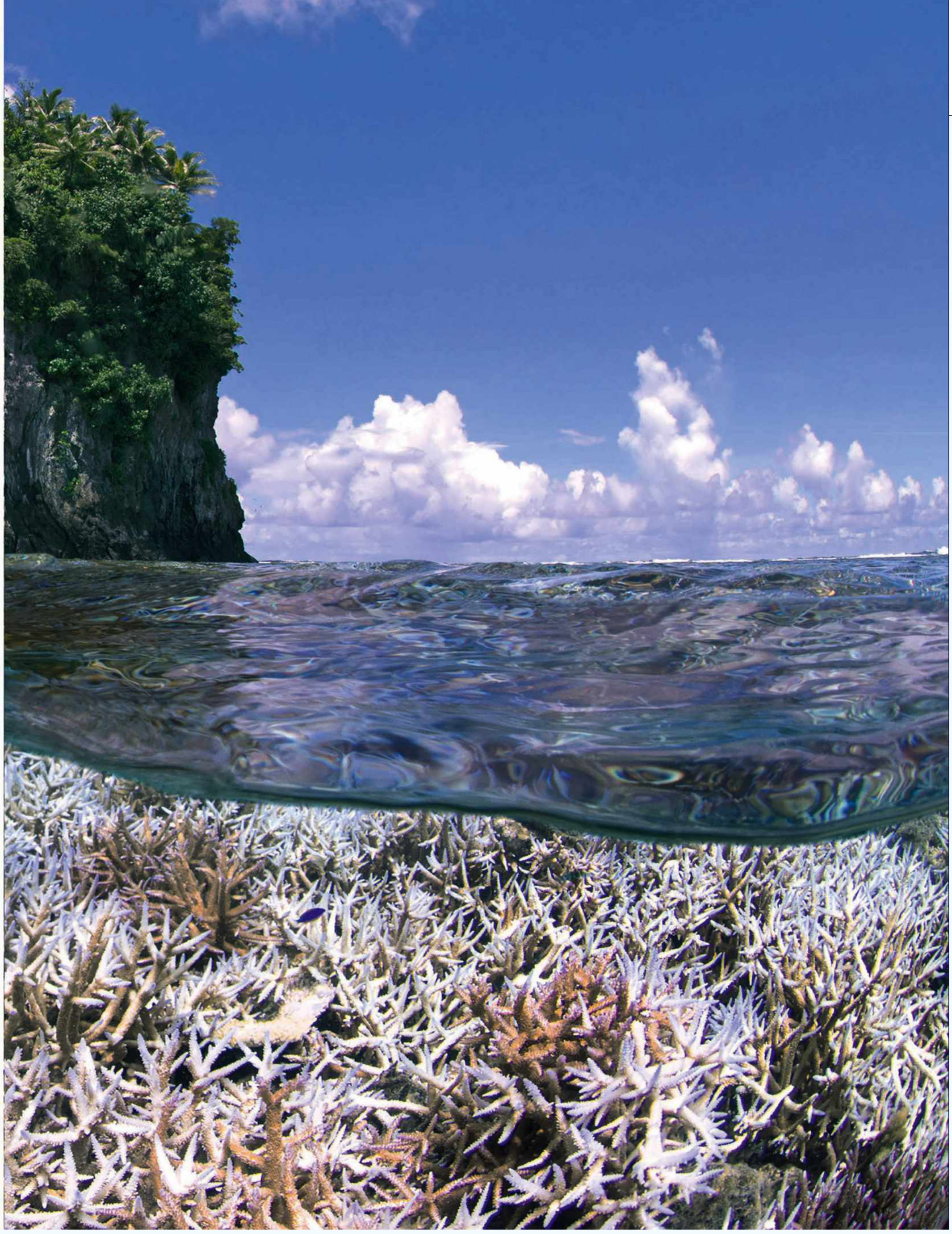
Dr Daniel Harrison, an oceanographer at Southern Cross University in Australia, is currently investigating the technique. His experiment, which has received funding from the Australian government as well as ARIA, is looking at whether fans could be used to spray seawater over the Great

> "YOU COOL THE AIR, AND THE WINDS AND OCEAN CURRENTS TRANSPORT THE COOLER AIR TOWARDS LAND"

ABOVE A before (left) and after (right) showing how rising sea temperatures have bleached coral in American Samoa

RIGHT A photo of marine cloud brightening in progress over the Great Barrier Reef, with salt crystals from aerosolised seawater rising up to the clouds

OCEAN IMAGE BANK, ASSOCIATE PROFESSOR DANIEL HARRISON/ SOUTHERN CROSS UNIVERSITY



Barrier Reef. As the seawater is expelled, the salt crystals in the water rise into the clouds and form tiny droplets. The more such droplets are added to the clouds, the better they reflect sunlight.

"Fundamentally, we're trying to add extra cloud droplets by using sea salt," says Harrison. The fan his team has developed takes in seawater and air, compresses them together and blows them out. "A single fan produces 1,000 trillion droplets per second," says Harrison.

No one else has tried this before. "We're the first," says Harrison. "Somebody's got to be first."

Harrison and his team have built the technology and are working with the Great Barrier Reef Marine Park Authority to conduct an experiment over a section of the reef. Modelling suggests that alongside a reduction in emissions, "it's enough to really improve the trajectory of the reef into the future."

Without that reduction, "you see a benefit for a couple of decades and then it's overwhelmed by climate change," even with MCB, Harrison says.

Another idea, investigated by Wan, could be to use MCB over sections of the ocean, such as the Pacific, to provide a cooling effect on nearby land. Last year, she studied whether this technique could be used to reduce extreme heat waves in the western US. She found it could reduce the risk of heat exposure by up to 55 per cent in current conditions, although the effect is lessened or even reversed if the planet continues warming.

"You cool the air, and the winds and ocean currents transport the cooler air towards land," says Wan. "The cooler air will eventually displace other air masses and then you get effects that are more on the interior of continents as well, not just the coastal regions." The side-effects of such a technique, if any, remain unclear without any small-scale experimental research, however.

The prospect of even considering attempting such a technique at scale remains decades away, though. Not only would there need to be strict governance and regulation, but public perception would be crucial too. Efforts to conduct small-scale experiments in the past have

ELISE IMBEAU, REAL ICE

ABOVE Tests have been carried out to see if pumping seawater from beneath the ice onto its surface, where it can freeze, might help insulate it from warmer summer temperatures

TOP LEFT Crews working on the Arctic tests used large saws to widen holes in the ice to install the seawater pumping equipment

BOTTOM LEFT Big batteries were used to power the pumping equipment during the tests

"IF YOU CAN'T GET PUBLIC BUY-IN, THERE'S NO WAY ANY OF THIS IS EVER GOING TO BECOME LARGE SCALE"

been controversial. In May 2024, an MCB experiment on an aircraft carrier docked in San Francisco was halted before it began after local opposition.

"If you can't get public buy-in, there's no way any of this is ever going to become large-scale," says Wan. "That's the challenge."

THICKER ICE

Another geoengineering technique that could be beneficial is sea ice thickening. Arctic sea ice loss is a major effect of climate change. According to NASA, Arctic sea ice is shrinking at a rate of 12.2 per cent per decade. By 2040, it's estimated that the Arctic could be completely devoid of ice during the summer months.

The knock-on effects could be dramatic, including rising sea levels, a weaker jet stream that could disrupt weather patterns, and changing ocean circulations. There are concerns that there could be a tipping point at which the changes are irreversible, even if we reduce emissions.

"You can imagine cascades of tipping points where ice sheets melt, ocean circulations change and forests die back," says Symes. "It's critical that we pay more attention to these tipping points."

Sea ice thickening could be one solution. Dr Shaun Fitzgerald, a climate scientist at the University of Cambridge, is leading a team to pump seawater out from below ice sheets and spread it over their surface, where it refreezes and provides an extra layer of insulation.

His team, with the help of local communities, has already begun small-scale experiments in northern Canada, pumping out about 1,000 litres (approx 250 gallons) of seawater a minute during the previous Arctic winter and thickening the sea ice by tens of centimetres (1–2ft) in a small area. They're now studying the area during the Arctic summer to see if the thicker ice persists, versus a control area where no pumping took place.

"It might have grown thicker, but did it actually last longer?" says Fitzgerald. "They're related, but different questions."

The goal is for the team to return in the winter and try the experiment again with help from funding by ARIA, and potentially scale it up in future to an area up to a kilometre (just over half a mile) across. "The big idea is if you can increase the overall extent of sea ice in the Arctic summer, that'll help with the overall radiation balance," says Fitzgerald. "We're seeing an ever-diminishing extent of sea ice, so this is a major concern."

ATMOSPHERIC INJECTION

What might be the most controversial geoengineering idea involves injecting particles into the atmosphere to reflect more sunlight. Known as Stratospheric Aerosol Injection (SAI), the technique has received considerable opposition, not least because its side effects aren't fully known.

"Solar-radiation management is extremely controversial," says Gerrard. "It's important that we know how it works, how well it works and whether it has negative effects."

At its core, the idea involves depositing particles of a material, such as sulphur, calcium or even diamond dust, into the stratosphere, the region of the atmosphere that extends from about 6–50km (4–30 miles) above Earth's surface. These particles would increase the reflectivity of the stratosphere, reflecting more sunlight into space and cooling the planet.

The idea is similar to how volcanic eruptions have cooled Earth in the past, spewing large amounts of sulphur dioxide into the atmosphere. The 1991 eruption of Mount Pinatubo in the Philippines, for example, is estimated to have cooled the planet by half a degree the following year.

No SAI experiment has ever been conducted, although there have been attempts. One project funded by ARIA will perform a SAI experiment, of sorts, using weather balloons to loft equipment into the stratosphere to examine how different materials age in the stratosphere. Nothing will be released into the stratosphere as part of the experiment. Instead, a tray containing samples will be exposed and the effects of the stratosphere on the samples will be studied on the ground.

"[The samples are] out sitting in the stratosphere where they're subjected to UV, light, ozone and all the other harsh conditions that are up there," says Symes. "That'll give an idea of not only how they

ABOVE Reflecting sunlight with a shade in space is perhaps one of the most fantastical proposals for cooling the planet

GETTY IMAGES

might behave in the stratosphere, but also what the impacts might be if they were ever used at scale."

SAI, if employed on a large scale, could provide a temporary cooling effect either to particular regions or the entire globe. Aircraft could deposit aerosols into the atmosphere over months, which would mix across the entire stratosphere in a couple of years. The aerosols would eventually fall out of the atmosphere if not replenished, but could be a temporary measure to provide a cooling effect on the ground.

"There's significant evidence that some of these sunlight reflection methods could reduce climate change substantially, reducing human impacts for the most vulnerable," says Prof David Keith, a climate scientist at the University of Chicago in the US.

Public perception of proposals like this remains a sticking point, but some surveys have shown that people would support research into SAI. "The really big picture is that things are changing very quickly on this topic," says Keith, with endeavours such as ARIA now taking tentative steps towards understanding SAI in more detail.

SPACE SHADES

A more far-fetched geoengineering idea would take place in space. Using large shades or mirrors, it might be possible to reflect some sunlight before it reaches Earth, providing a cooling effect for certain parts of the planet.

No experiment to attempt this idea is underway, although ARIA is funding a modelling study from the Planetary Sunshade Foundation in the US to look into the feasibility of it. How, or even if, this technique might work is something "we definitely don't know," says Symes.

The idea is that, somewhere between Earth and the Sun, a large shade or series of shades would be deployed, lessening the amount of sunlight reaching the planet. The amount could be extremely small, so small that there would be no noticeable difference on Earth, but enough to lower temperatures in some parts of the planet.

"We're talking about removing tiny percentages of incoming sunlight," says Symes. For the moment, the idea remains extremely speculative. "We might have a better idea after the project has completed the modelling," says Symes.

Even if such an idea remains a pipe dream, it highlights the growing desire of scientists to see research into geoengineering take place, even if it ultimately amounts to nothing. The field is "definitely growing," says Wan, "because there's this urgency to do something with climate change."

The overall goal remains to reduce emissions. But if some effects of climate change can't be averted before we do so, might it be worthwhile to carry out temporary measures that could potentially save millions of lives? At the very least, research into such measures is vital.

There's also currently little global regulation on geoengineering, meaning that knowing the effects of different techniques is particularly important if any country or company were to attempt one of them. "This is a totally ungoverned area," says Gerrard. "A concern I have is that a rogue state, or even a billionaire, could do this on their own and wouldn't require anybody's approval."

We may start to see the first peer-reviewed publications from ARIA's projects in the next year or two, alongside other work taking place elsewhere. "We're trying to be as transparent as we can," says Symes, "so that people can see these [projects] aren't scary. They're really small, they have well-defined aims and they have expert [scientists] who have spent their whole careers researching these phenomena."

Will geoengineering save the planet? We may find out in the years to come. **SF**

by **JONATHAN O'CALLAGHAN**

Jonathan is an award-winning freelance science journalist based in the UK.

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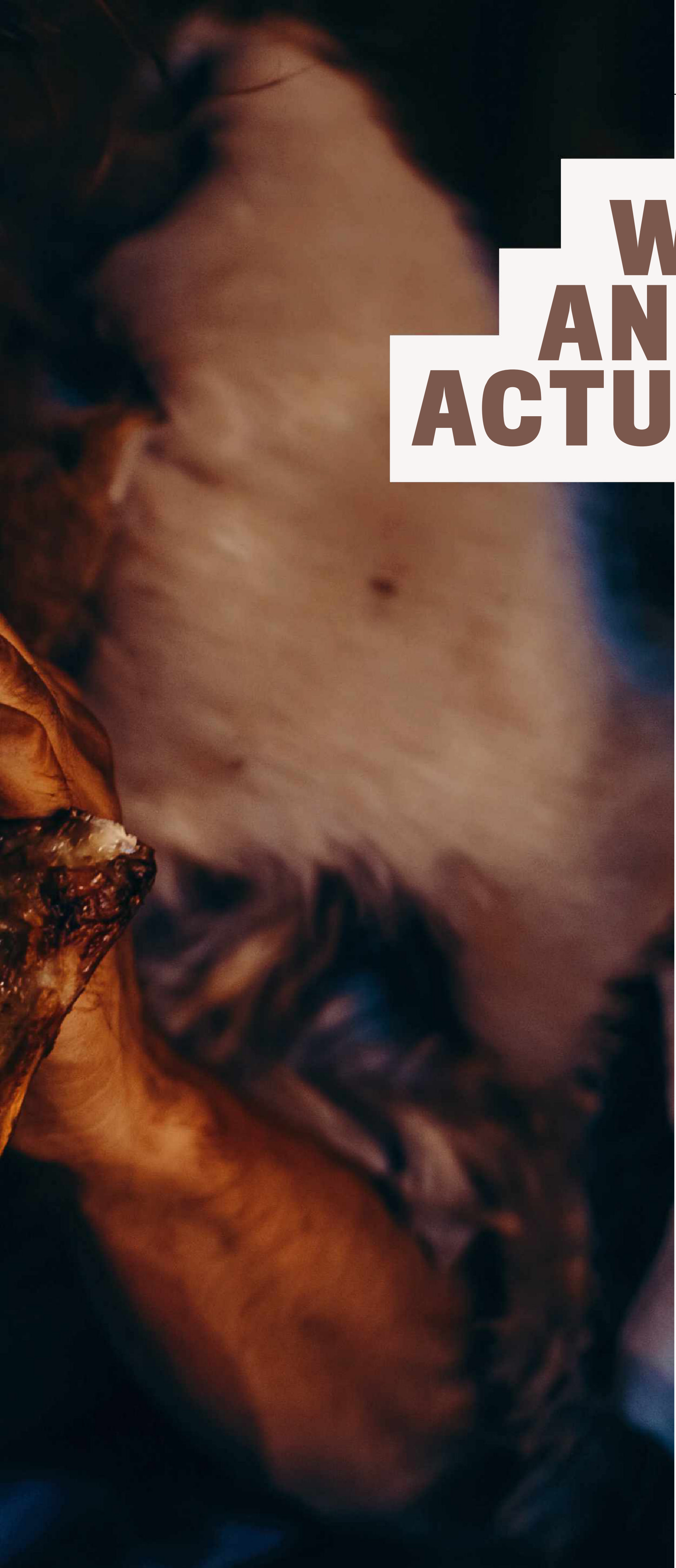

WHAT OUR ANCESTORS ACTUALLY ATE

Our hunter-gatherer forebears weren't the carnivorous cavemen we once thought. Which makes trying to build a diet based on what they ate not only unwise, but practically impossible

by HATTY WILLMOTH

Imagine doing your entire food shop at a butcher's. No vegetables, no bread, no fruit, no pasta, milk or biscuits – just a trolley full of meat, fish, eggs and lard.

That's the carnivore diet. Its gospel has been preached all over the internet – by fitness influencer Brian Johnson (aka Liver King), Canadian psychologist Jordan Peterson and podcaster Joe Rogan (who said the diet gave him "sporadic bouts of hellacious projectile doodoo").

But despite such vivid imagery, the carnivore cult is growing. Data from Google Trends shows that searches for the term "carnivore diet" roughly tripled in the UK and US from 2022 to 2025, and there are now more than 160 carnivore cookbooks listed for sale on Amazon.

There's no real science proving the diet is beneficial, but many meat munchers feel confident in their choice because they think our hunter-gatherer ancestors ate mainly (or only) animals. The carnivore diet, they say, is a better fit for our biology than a modern diet of carbohydrates, processed foods and farmed plants. It's what we evolved to eat.

But here's the thing: there's a limit to what *The Flintstones* can teach us about nutrition. What people imagine to be 'ancestral' eating is not only inaccurate, but often unhealthy. And any lessons we can learn from our Stone Age predecessors are nothing like what the podcast bros would have you believe.

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'MAN THE HUNTER'

The first thing to note is that our ancestors weren't actually carnivores. That's a misplaced narrative based on outdated archaeology.

Dr Emma Pomeroy is an Associate Professor in the Evolution of Health, Diet and Disease at the University of Cambridge. She says: “We have this idea of cavemen – and it usually is men – eating a very high meat diet and not relying on anything else. For most humans, that wasn’t the case.”

Why, then, do so many of us think it was? Well, animal bones and stone tools can survive for ages, so archaeologists have long had clear evidence that early humans hunted, butchered and ate animals. Plant matter, on the other hand, decomposes quickly.

So, the archaeological record has traditionally been “biased towards the hunting record,” as a result, explains Prof Dorian Fuller, an archaeobotanist at University College London.

We know better now. Archaeologists have amassed a wealth of evidence that our ancestors ate plants. Some of the strongest comes from isotope analysis. Isotopes are distinct versions of chemicals that can give us clues about what humans ingested during their lives.

“You can analyse bones and tooth enamel for isotopes,” says Fuller. “All the isotopes in humans come from what we ate and there are different variants.”

For example, nitrogen gets heavier every time it’s eaten. It’s light in plants, heavier in herbivores, heavier still in carnivores – so the atomic weight of the nitrogen in an animal’s remains (human or otherwise) can give archaeologists an indication about where that animal’s diet fell on the food chain.

Similarly, different plants have different carbon isotopes. So, depending on the types of carbon found in a skeleton, archaeologists can guess the type of plants that a person ate.

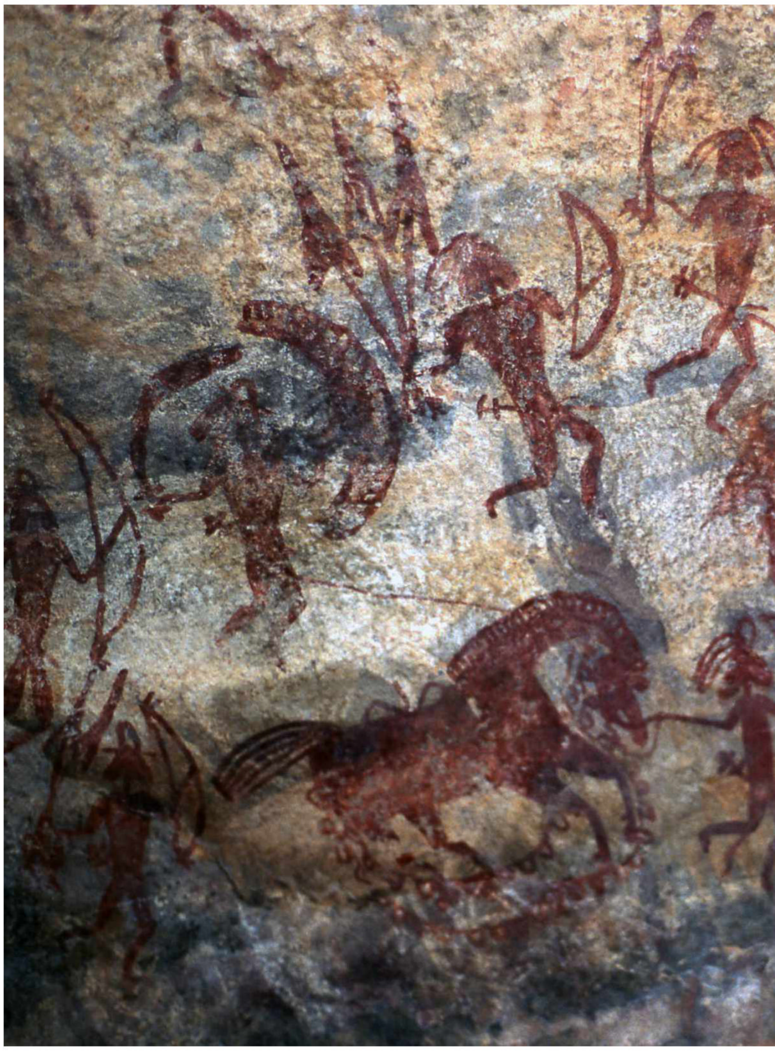
“If you combine that with the nitrogen isotopes, you can guess, ‘This looks like a diet that’s high in fish and nuts,’” says Fuller. “Or, ‘This looks like it’s high in meat and millet.’”

This is how a 2024 study was able to conclude that Stone Age hunter-gatherers in Taforalt, Morocco, were mainly eating plants up to 15,000 years ago. Scientists at the Max Planck Institute for Evolutionary Anthropology, in Germany, analysed the isotopes of zinc, strontium, carbon, nitrogen and sulphur from dental enamel, bone collagen and plant remains. Doing so revealed that this Palaeolithic group were more gatherers than hunters, relying on plant foods such as acorns, oats and pistachios for survival.

Archaeologists can also analyse the gunk that builds up on unbrushed teeth, which Pomeroy describes as “a really amazing source of information on what people were eating.” As that gunk forms, it traps particles of food and plant fragments. Archaeologists can analyse DNA from those tiny pieces to find out exactly what a person ate.

Then there’s ethnographic evidence – studies on modern hunter-gatherer populations. A 2023 study found that, out of 63 foraging societies studied in the last 100 years, there was clear evidence that women hunted in 50 of them (79 per cent). And we also know that modern hunter-gatherers usually eat a lot of plants. The Tsimané of the Amazon get a lot of their calories from plantains and manioc, for instance, while Australian Aboriginals eat plenty of nut grass and water chestnuts.

For Pomeroy, this makes sense. “Plant foods are much more reliable than meat,” she says. “Yes, hunters might bring back a large amount of meat in one go. But on days when they don’t, people still have to eat. So, that reliable aspect of the diet, in many populations, would have been the plant foods.”



“NOT ONLY IS OUR FOOD DIFFERENT TO THAT OF OUR ANCESTORS, BUT SO ARE WE”

ADAPT OR DIE

Palaeolithic people ate plants; the evidence for that is clear. But that doesn’t mean all Palaeolithic people ate the same things – that there was a single, homogenous Palaeolithic diet.

Palaeolithic humans lived across vastly different environments, from forests and deserts, to savannas and mountains. In fact, a 2018 paper argued that part of the reason why *Homo sapiens* outlived previous hominins was our ability to live in a wide variety of challenging landscapes – something it called the ‘generalist specialist’ niche.

In Sri Lanka, says Fuller, we have evidence that hunter-gatherers foraged for most of their diet, eating plenty of nuts and wild fruits, while also learning to shoot small monkeys and birds in the forest. Whereas, in the Arctic Circle, the traditional diet of Inuit populations has long consisted of whale and seal blubber without many plants, because that’s what is available there.

Even if there was one ‘genuine’ Palaeolithic diet, you couldn’t follow it now even if you wanted to, because the foods they ate simply don’t exist anymore – certainly not on supermarket shelves.

For example, the wild melons gathered by our ancestors were bitter and sour, whereas ours have been made sweet by centuries of selecting the tastiest fruit to farm. Similarly, their grains would have been smaller, less starchy and more fibrous than ours. Their peaches were cherry-sized, their bananas were full of pips and their carrots were thin and white or purple.

Agriculture changed all that. Over millennia, farmers have chosen plants that they like to grow and eat, and our food has morphed as a result. Generally, it has become sweeter, starchier and less fibrous.

“We’ve selected cereals that have slightly more carbohydrate than their wild ancestors and mutated forms of fruit that are high in sugar,” says Fuller. “If you wanted to take those out of your diet, you’d have to try to find non-sweet versions of these things, which would be very hard to do.”

It’s much the same story when it comes to meat, adds Pomeroy. We’ve bred our livestock to be larger, so they produce more meat per animal. But also, hunter-gatherers would have eaten their prey from nose to tail, not just selected a few choice cuts.

“It’s very rare that people who claim to be eating these diets are eating the brain, the lungs, the eyes, the tongue, all the internal organs, the bone marrow,” says Pomeroy. “But people used the whole thing. It’s hard work hunting and you’re not just going to say, ‘I’ll have a nice bit of rump steak.’”

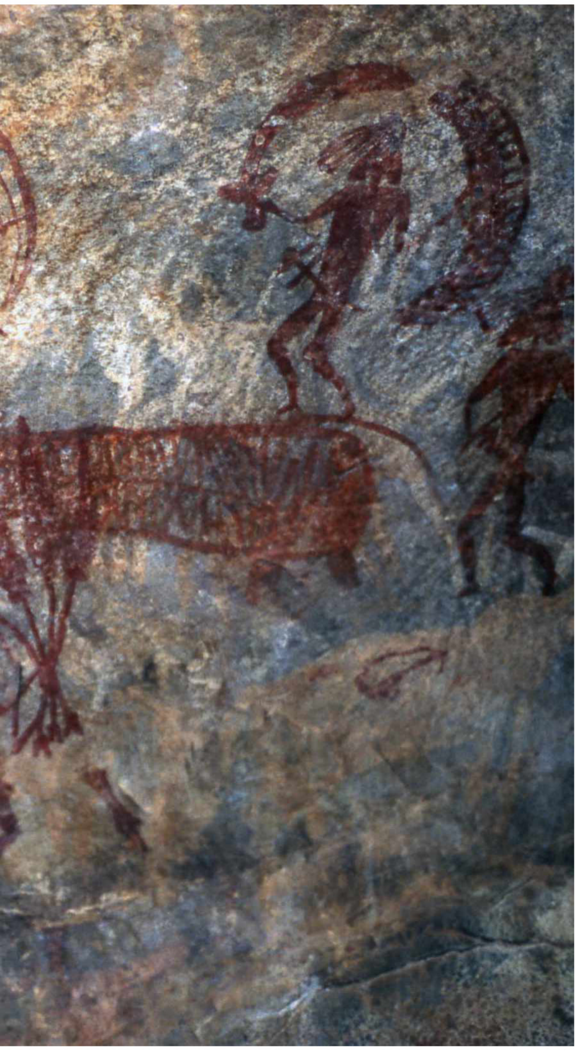
DIFFERENT DIETS, DIFFERENT BODIES

Not only is our food different to that of our ancestors, but so are we. Our bodies have adapted to cope with our agricultural diets and Pomeroy says it’s “problematic” to suggest otherwise.

“We know that human populations have evolved to eat some of the products of agriculture,” she says. “A classic example is lactase persistence. Mammals stop consuming milk once we’ve been weaned, so we don’t need lactase – the enzyme that breaks down the sugars in milk.” Yet, populations that relied on cattle and dairy products for survival have developed lactase persistence, so they can digest dairy throughout adulthood.

Another example is amylase enzymes, which break down starches for digestion. Modern humans have more amylase enzymes than other primates, including gorillas, chimpanzees and our hominin predecessors such as Neanderthals.

“But, within modern humans, there’s a huge amount of variation,” says Fuller. “Some populations have three or four copies [of the amylase gene], some populations have 12.”



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FAR LEFT Brian Johnson – the self-styled ‘Liver King’ – promoted a diet based on eating raw, unprocessed meat and organs

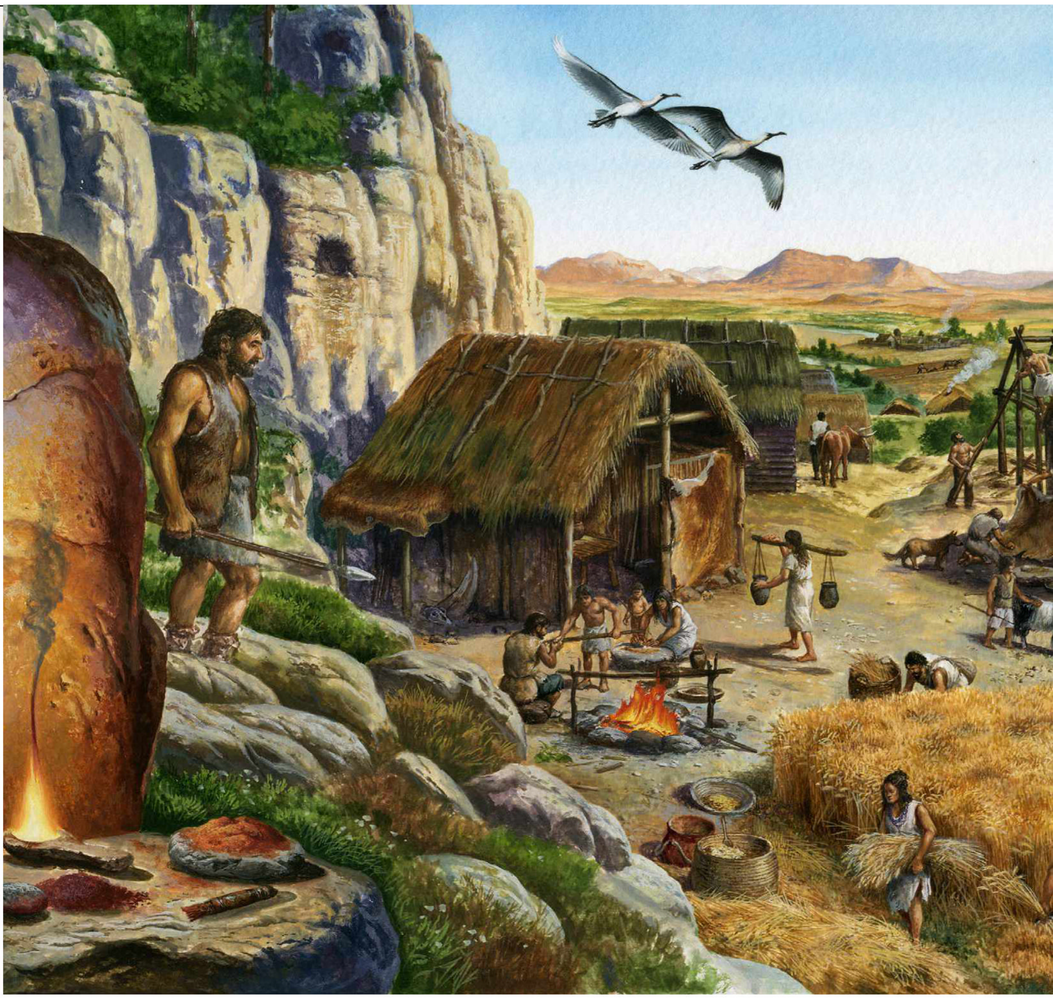
LEFT The Bhimbetka Cave paintings, believed to date back to 10,000–30,000 years BC, depict aspects of life for hunter-gatherer societies during the Palaeolithic

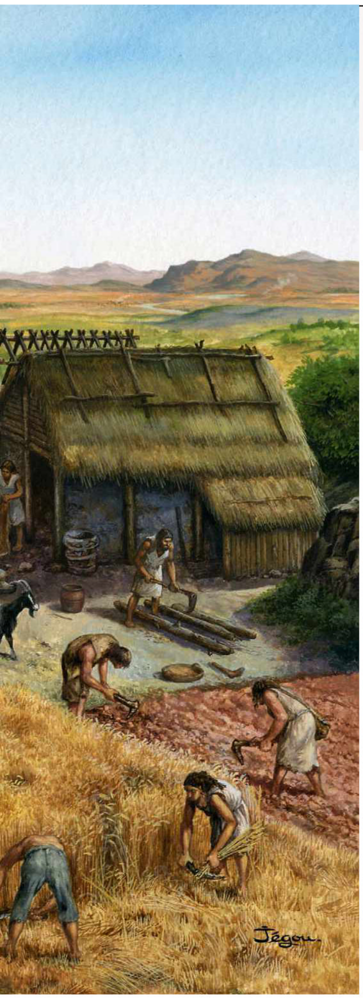
So, some human groups now have genetics that are better suited to higher starch diets, indicating that they may have been historically reliant on sources of carbohydrate – such as grains, cereals and tubers – for survival. That's the case in temperate environments, far away from the poles and equator, such as Britain and much of North America.

Meanwhile, Inuit people who live in the Greenland Arctic have undergone genetic adaptations to cope with their meat-based diets, says Pomeroy. "Their metabolism has adapted to enable them to eat that high-fat diet without the metabolic risk that we would see if most people in other countries were to eat that kind of diet."

All over the world, we've evolved and adapted to our environments, just as our Palaeolithic ancestors did. So, attempting to revert to our Stone Age diets might not be best for our biology.

But, for argument's sake, let's assume that you could pick a Palaeolithic diet suited to your biology, that you could find Stone Age crops and that your body wouldn't reject your new menu. You would still be living in an agricultural society.





LEFT The Neolithic period was characterised by the shift to agriculture, which changed our bodies and our societies

BELOW LEFT Dr Emma Pomeroy is associate professor in the evolution of health, diet and disease at the University of Cambridge

SCIENCE PHOTO LIBRARY, GETTY IMAGES

“THE ADVENT OF AGRICULTURE ENABLED HUMANS TO LIVE LONGER”

Unless you’re hunting and foraging all day in Stone Age landscapes, you wouldn’t be living the lifestyle of a Palaeolithic person. You wouldn’t be surviving off what you could find – and that’s probably a good thing. Visions of the Palaeolithic past tend to romanticise it as the nutritional and evolutionary ideal, but it could be precarious.

The advent of agriculture enabled humans to live longer, grow in population and enjoy more reliable access to food. As Pomeroy says, “I don’t think anyone would want to move away from the food security that we have in rich countries today.”

In other words, just because something might be ‘what our ancestors did,’ it doesn’t mean it’s what they wanted to do. They probably would have liked reliable access to food, thank you very much.

MORE VARIATION

Perhaps, the most annoying thing about fans of the carnivore diet, however, is that they do have a point. Even though we’re living longer and there are more of us compared to Stone Age times, Pomeroy says that skeletons from agricultural societies seem to have more signs of chronic disease, such as diabetes and heart disease. And, in the last few centuries, what we eat has changed a lot.

“The nugget of truth here is the food system has rapidly changed over the last couple of hundred years and our biology hasn’t to that extent,” says Dr Emily Leeming, a dietitian and scientist at King’s College London.

But, while Paleo and carnivore fans may have spotted this problem, they’ve got the solution all wrong. Leeming says the ‘ancestor diet’ trope is often attached to diets that “end up being incredibly restrictive,” centred on demonising and cutting out entire food groups. But Pomeroy, Fuller and Leeming all agree that what we need is more variation, not restriction.

“The real problem with an agricultural diet, if we can call it that, is the reduction in the diversity of plant foods,” says Fuller. He explains that we rely too heavily on carb-rich foods such as wheat, rice and corn, while missing out on a wide range of fruits, vegetables, nuts, seeds and legumes.

“We’ve become quite narrow in the plants that we eat,” agrees Pomeroy. She adds that we process foods more than we did in hunter-gatherer times. We would have eaten whole fruits and whole grains with their fibre intact.

“We think the ancestral diet was incredibly diverse, really high in fibre, with lots of different plant foods and fibre types,” says Leeming, adding that our gut health would have benefited from a “wealth of different types of microbes, far more than we have in our diets now.”

Also, says Leeming, a key source of fibre is whole grains. Paleo and carnivore diets restrict or eliminate this food group because it’s a source of carbohydrate, aka sugar, something proponents of these diets say Palaeolithic people didn’t eat. But we know that our ancestors were eating grains.

Those of us in the modern western world, in contrast, are “seriously lacking whole grains”, says Leeming. “This has real consequences, not just for your gut microbiome, but the health of your entire gut – things like bowel cancer – and also heart health and metabolic health, including type 2 diabetes.”

Fuller adds we have evidence, too, that Palaeolithic people were eating more nuts and seeds than we do today, and benefitting from healthy fats such as omega-3, good for longevity and the brain.

EATING FOR SURVIVAL

All in all, everything that we assume about Stone Age diets is wrong. Our ancestors didn’t just eat meat, they ate different things depending on where they lived and, usually, plenty of plants. That’s because Palaeolithic people weren’t eating to get ‘ripped’, chase podcast stardom or start arguments on social media. Their diets were all about survival. To survive, they adapted to their environments. And, if we want to continue to survive, we need to adapt how we eat too. For Fuller, Pomeroy and Leeming, that means eating with the climate in mind.

Leeming says that if we’re to stick around, our diets should consider both nutrition and sustainability. This means prioritising vegetables and fruits, followed by wholegrains and plant-based protein sources, with minimal meat and dairy products. Because, in the end, it doesn’t really matter what our ancestors ate. We live in different environments, with different foods, facing a different set of challenges. Our ancestors did what they could to survive. Now it’s our turn. **SF**

by **HATTY WILLMOTH**

Hatty is a trends editor at BBC Science Focus*. Her areas of interest include food, nutrition and health.*

THE BIG QUESTION

Should my next boss be an artificial intelligence?

Humans are emotional, irrational and biased. Hardly an ideal recipe for running a company. So would an AI do a better job?

by **PROF TONY PRESCOTT**

Elon Musk is rarely out of the news these days. Widely acknowledged to be the world's richest man, he's also known for running a number of major companies. The trouble is, some of those companies haven't been doing so well lately.

Twitter (now known as X) is said to have lost around 75 per cent of its value during Musk's time as CEO. Meanwhile, sales of Teslas, the electric cars made by another company Musk is currently CEO of, are said to be slumping despite a wider increase in registrations of electric vehicles generally.

One of Tesla's major investors has publicly called for Musk to step down as CEO and there have been rumours (denied by the company) that the board might be seeking to replace him. But if someone else were to take his place, who's to say they'd do any better? Maybe Musk is doing the best any human could under the circumstances. Maybe, given the demands of the job, a human just isn't enough. But could an artificial intelligence (AI) be up to the task?

"Creativity and social intelligence tend to be the traits people assume will ensure humans keep these top jobs"

In an attempt to answer this question, I asked a large-language model (LLM) AI directly, giving it this prompt: "You are the CEO of an electric vehicle firm with a turnover of $100 billion, selling nearly 2 million cars a year and with over 100,000 employees. What would be your strategy for growing the business over the next five years?"

The AI replied, almost instantly, with a 350-word answer beginning: "…I'd implement a five-year growth strategy focused on scaling intelligently, deepening ecosystem control and pioneering innovation – all while navigating geopolitical, environmental and technological shifts…" It then proceeded to outline what it called "a strategic blueprint across six core pillars", with the focus being to sell more cars into unpenetrated markets.

I know next to nothing about running a car company (I'm a robotics professor at a UK university), but the strategy looked plausible, scaled to the outlook

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Human flaws and hubris are, arguably, the last things you want in the boardroom, when so many people's livelihoods and lives hinge on the decisions being made

and size of a multinational company, and attuned to global opportunities. I would say that I was impressed, except that I'm used to LLMs providing these kinds of well-informed answers to challenging questions.

But as well as being a robotics professor, I'm also a co-founder of two UK robotics startups, though I've never been a CEO. Given this background, I tried the AI again, this time with the prompt: "You are the CEO of a small startup robotics company with enough budget to cover running costs for 12 months. You need to choose between either investing in research and development or pushing hard to gain sales with your current product. Which should it be?"

Once again, the AI gave me a rapid and reasoned response: "As the CEO of a small startup robotics company with only 12 months of runway, you must prioritise customer validation and sales traction with your product, rather than diverting heavily into research and development. Here's the reasoning and how to execute the right strategy…"

I'm in a (slightly) better position to assess this advice and can say that I found it credible, both in terms of what needed to be done and how to execute. So, going back to the big question: could an AI actually do a CEO's job? Or, to look at this another way, what kind of intelligence, artificial or otherwise, do you need to be a great CEO?

INTANGIBLE SKILLS

In 2023, the international management consultancy McKinsey published an article on what makes a successful CEO. The CEO's main task, as McKinsey sees it, is to develop the company's strategy and then ensure that its resources are suitably deployed to execute that strategy. It's a tough job and many human CEOs fail. McKinsey reported that only three out of five new CEOs met company expectations during their first 18 months in the role.

We've already seen that AIs can be strategic and, given the right information, can formulate and articulate a business plan, so they might be able to perform this key aspect of the CEO's role. But what about the other skills a good corporate leader should have?

Creativity and social intelligence tend to be the traits that people assume will ensure humans keep these top jobs. People skills are also identified by McKinsey as important for CEOs, as well as the ability to see new business opportunities that others might miss – a kind of creative insight AIs currently lack, not least because they get most of their training data second-hand from us.

Many companies are already using AI as a tool for strategy development and execution, but you need to drive that process with the right questions and critically assess the results. For this, it still helps to have direct, real-world experience.

CALCULATED RISK

Another way of looking at the CEO replacement question is not what makes a good CEO, but what makes a bad one? Because if AI could just be better than some of the bad CEOs (remember, two out of five don't meet expectations), then AI might be what's needed for the many companies labouring under poor leadership.

Sometimes the traits that help people become corporate leaders may actually make it harder for them to be a good CEO: narcissism, for example. This kind of strong self-belief might help you progress your career, but when you get to CEO, you need a broader perspective so you can think about what's good for the company as a whole.

A growing scientific literature also suggests that those who rise to the top of the corporate ladder may be more likely to have psychopathic tendencies (some believe that the global financial crisis of 2007 was triggered, in part, by psychopathic risk-taking and bad corporate behaviour). In this context AI leadership has the potential to be a safer option with a more measured approach to risk.

Other studies have looked at bias in company leadership. An AI could be less biased, for instance, hiring new board members based on their track record and skills, and without prejudging people based on gender or ethnic bias. We should, however, be wary that the practice of training AIs on human data means that they can inherit our biases too.

A good CEO is also a generalist; they need to be flexible and quick to analyse problems and situations. In my book, *The Psychology of Artificial Intelligence*, I've argued that although AI has surpassed humans in some specialised domains, more fundamental progress is needed before AI could be said to have the same kind of flexible, general intelligence as a person.

> **"In this context, AI leadership has the potential to be a safer option with a more measured approach to risk"**

by **PROF TONY PRESCOTT**

Tony is professor of cognitive robotics at the University of Sheffield, UK, the co-founder and former director of Sheffield Robotics, and the author of The Psychology of Artificial Intelligence *(Routledge, 2024).*

In other words, we may have some of the components needed to build our AI CEO, but putting the parts together is a not-to-be-underestimated challenge.

Funnily enough, human CEOs, on the whole, are big AI enthusiasts. A 2025 CEO survey by consultancy firm PwC found that "more than half (56 per cent) tell us that generative AI [the kind that appeared in 2022 and can process and respond to requests made with conversational language] has resulted in efficiencies in how employees use their time, while around one-third report increased revenue (32 per cent) and profitability (34 per cent)." So CEOs seem keen to embrace AI, but perhaps less so when it comes to the boardroom – according to a PwC report from 2018, out of nine job categories, "senior officials and managers" were deemed to be the least likely to be automated.

Returning to Elon Musk, his job as the boss of Tesla seems pretty safe for now. But for anyone thinking about who'll succeed him as CEO, you could be forgiven for wondering if it might be an AI rather than one of his human boardroom colleagues. **SF**

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People skills, as well as the ability to assess situations and think strategically, are sought-after traits in a CEO

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Q&A

YOUR QUESTIONS ANSWERED

JOSHUA NEWMAN, PETERBOROUGH

CAN ANIMALS GET DRUNK?

It's not hard to find stories of animals getting tipsy. A moose in Sweden was found with its head stuck in a tree after being seen staggering around, eating fermented apples. Elephants in Botswana getting drunk on marula fruit. My pet rat, who would knock over my home brew and then lick up the spillage. They all seemed inebriated, but were they?

If you know where to look, the natural world is one big pub, with alcohol on tap in the form of fermented fruits, sap and nectar. Much like us, different animals have different tolerance levels.

As a rule of thumb, those that eat fermented foods regularly, metabolise the alcohol more rapidly, and are less affected by it. Malaysia's pen-tailed shrew has evolved to survive on the fermented

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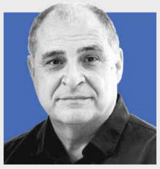
Astrophysics



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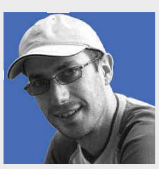

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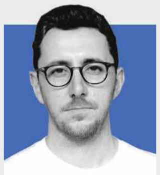

IAN TAYLOR
Everyday science

> "IF YOU KNOW WHERE TO LOOK, THE NATURAL WORLD IS ONE BIG PUB, WITH ALCOHOL ON TAP IN THE FORM OF FERMENTED FRUITS, SAP AND NECTAR"

nectar of the bertam palm, and although they regularly consume large amounts – the equivalent of 10–12 glasses of wine, adjusted to body weight – they show no signs of intoxication.

The same is true for the native bats of Central and South America. They often eat fermented fruits and nectar, but can fly just as well when inebriated as when sober – even with blood-alcohol levels that are more than three times the legal human limit.

This is not the case for the cedar waxwings of North America. While these birds eat a lot of regular berries, from time to time they gorge on the over-ripe, boozy berries of the Brazilian pepper tree. This rarely ends well. The birds can't fly straight and have a tendency to crash into windows and fences. Tests on birds that have died in this way revealed that their livers had a blood alcohol content of up to 1,000 parts per million – levels that would easily intoxicate a human.

So, three key messages if you're a waxwing. Never 'drink' and fly. Know your limits. And alcohol-free berries are readily available! ***HP***

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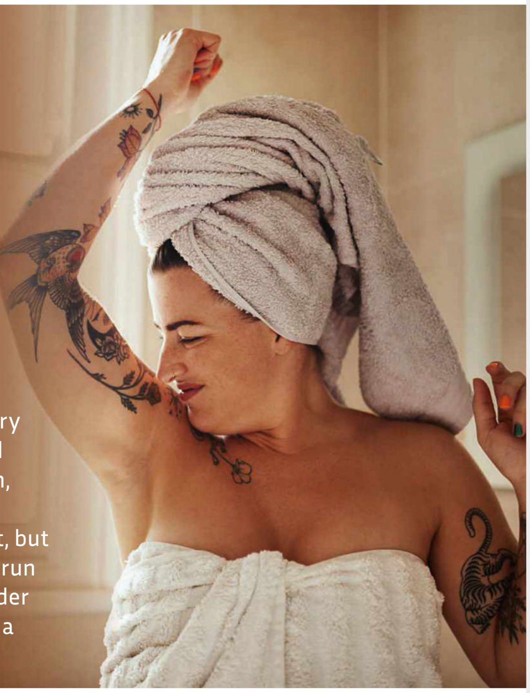
BETH CLARKE, LONDON

HOW CAN I FIND OUT IF I SMELL?



We all stink some of the time, when bacteria get stuck in the sweat produced by our apocrine glands. The problem is that our senses can become accustomed to common smells, even the dodgy ones.

It's called nose blindness or olfactory fatigue. It's the reason you can't smell your dog in the house, but visitors can, for example.

There are suggested ways around it, but they're not well-studied. One tip is to run clean fingertips over your scalp or under your arms, and then give your fingers a cautionary sniff. ***IT***

DEFIBRILLATOR
TO OPEN
TO OPEN IN AN EMERGENCY:
1. CALL 999
2. KEEP CALM & FOLLOW INSTRUCTIONS
3. TELL THE CALL OPERATOR YOU ARE AT LOCATION:
4. YOU WILL BE GIVEN AN UNLOCK CODE
5. STAY ON THE LINE FOR FURTHER GUIDANCE

ANGUS WRIGHT, VIA EMAIL

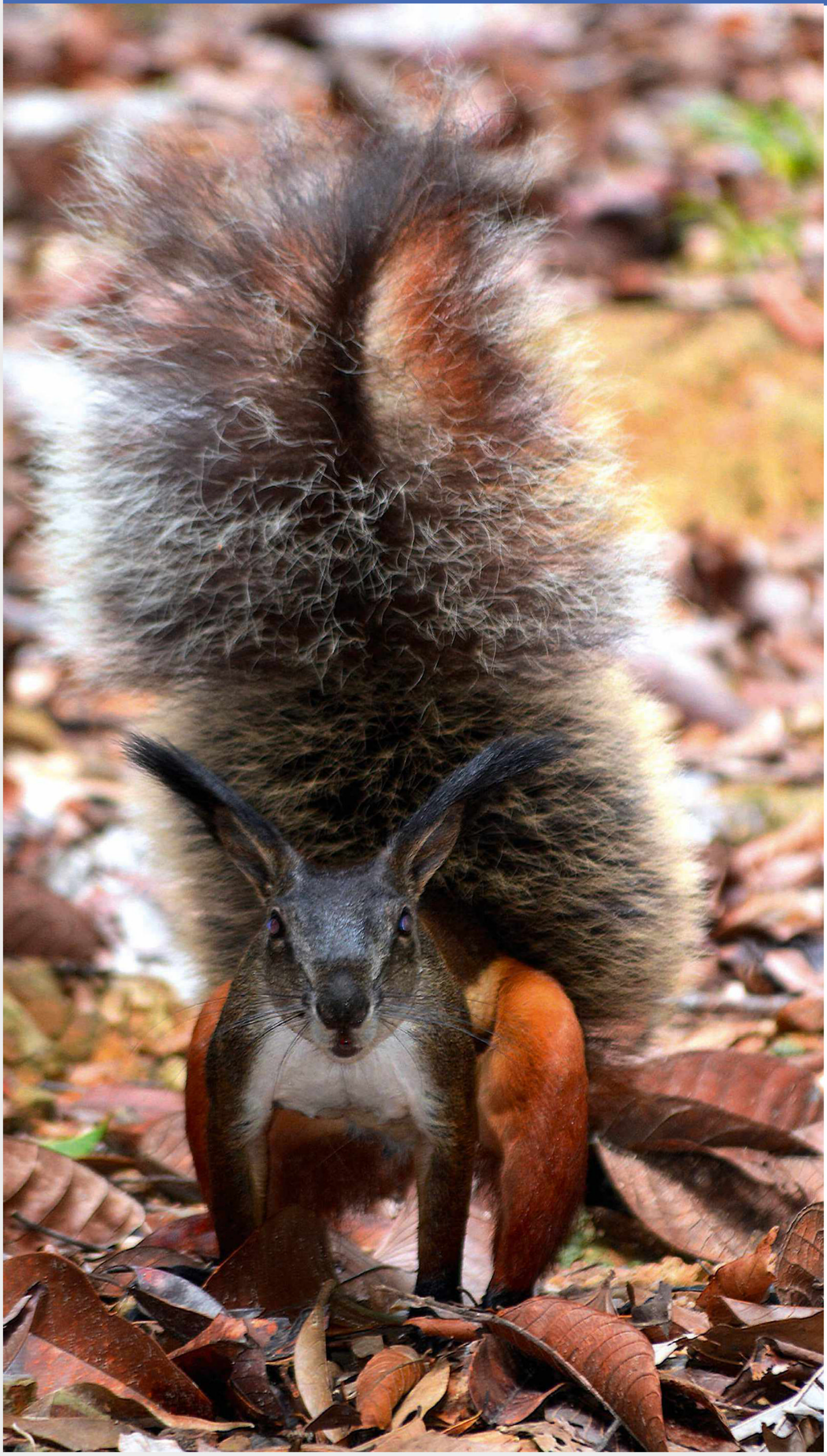
WHAT'S THE MOST EFFECTIVE WAY TO USE A DEFIBRILLATOR?

Traditionally, one pad is placed on the upper right chest and the other on the lower left (known as anterior-lateral placement), but recent evidence suggests that an anterior-posterior (front-back) placement might improve survival rates.

Scientists from Oregon Health & Science University have published a new observational study in *JAMA Network Open*, which found that patients with AP pad placement had a 2.64-fold greater odds of return of spontaneous circulation (ROSC) compared to those with anterior-lateral (AL) placement.

Further research is needed on this new placement, though. Currently, the guidance is to stick to the anterior-lateral placement. ***NM***

NATURE'S WEIRDEST CREATURES



THE TUFTED GROUND SQUIRREL

You know when you stare at cute things for too long and they start to look creepy? I'm thinking garden gnomes, baby dolls, any child in a princess outfit and all cats. Well, now there's another one to add to the list. The tufted ground squirrel *(rheithrosciurus macrotis)* might *look* bright-eyed and bushy-tailed, but according to the Dayak hunters of Borneo where it lives, it's a cold-blooded killer.

Dubbed the "vampire squirrel," the ruthless rodent is said to hurl itself onto the backs of passing deer, use its razor-sharp teeth to slash through the jugular vein and then leave the animals to bleed to death. Locals who have discovered disembowelled deer carcasses in forests believe that the squirrels then return to the kill site and feast on the deer's heart, liver and stomach contents. Meanwhile, in villages close to the forest's edge, tufted ground squirrels are said to kill domestic chickens and gorge on their hearts and livers.

The squirrel rose to notoriety in 2014, after a 15-year-old girl called Emily Meijaard wrote an academic paper about it with her parents. The paper, which described the bloodthirsty folklore surrounding the animal, was published in the *TAPROBANICA: The Journal of Asian Biodiversity*. And with that, an animal that had largely gone unnoticed for millennia, went viral. News stories were printed. Videos were posted. Beatrix Potter probably turned in her grave.

Then in 2015, they were caught on camera for the very first time.

They weren't savaging herbivores, though. Instead, they were foraging in the undergrowth of the Gunung Palung National Park in West Kalimantan. Hardly the actions of a killer, but more revelations were to come.

In 2020, researchers discovered that the squirrels' bizarre teeth – which feature long incisors with deeply carved ridges on the upper *and* lower jaw – are, in fact, used to crack very tough nuts. The tufted ground squirrel is actually an extremely specialised and dedicated seed predator, that relies heavily on the nuts of the canarium tree.

It seems that we got the tufted ground squirrel all wrong. They really are bright-eyed and bushy-tailed. So bushy-tailed in fact, that the furry appendage is 30 per cent bigger than their bodies, making it one of the most voluminous of all mammalian tails, relative to body size.

> "IN VILLAGES CLOSE TO THE FOREST'S EDGE, TUFTED GROUND SQUIRRELS ARE SAID TO KILL DOMESTIC CHICKENS AND GORGE ON THEIR HEARTS AND LIVERS"

Why this is, no one really knows. It's not for balance, because the squirrel spends most of its time on the forest floor looking for food. It's not for insulation, because it rarely gets that cold in Borneo. It could be to do with attracting a mate. It could have evolved to distract predators. Or it could be a form of cryptic camouflage – the tail has a grizzled charcoal colour with white frosting which may help the squirrel blend in with the forest floor.

Whatever the reason, it's time we stopped slandering the tufted ground squirrel and instead learned to love it for the genuinely cute critter that it really, truly is. ***HP***

ALAMY ILLUSTRATION: CRAIG BOYLAN

CONNOR BARRETT, SALFORD

HOW MUCH WILL EXERCISE CONTROL MY BLOOD PRESSURE?

High blood pressure is a major health concern, increasing the risk of heart disease, stroke and kidney problems. As a GP, I'm often asked how to manage it, and my advice always includes exercise. But how much is enough?

A 2021 study followed over 5,000 adults for 30 years, shedding light on the ideal 'dose' of exercise for blood pressure control. The key takeaway? It's not just about the type or intensity of exercise, it's the total amount that matters. The research suggests that aiming for 30 minutes of moderate-intensity activity most days of the week can significantly help. This includes activities where you can still talk but feel your breathing quicken, such as brisk walking, cycling or even active housework.

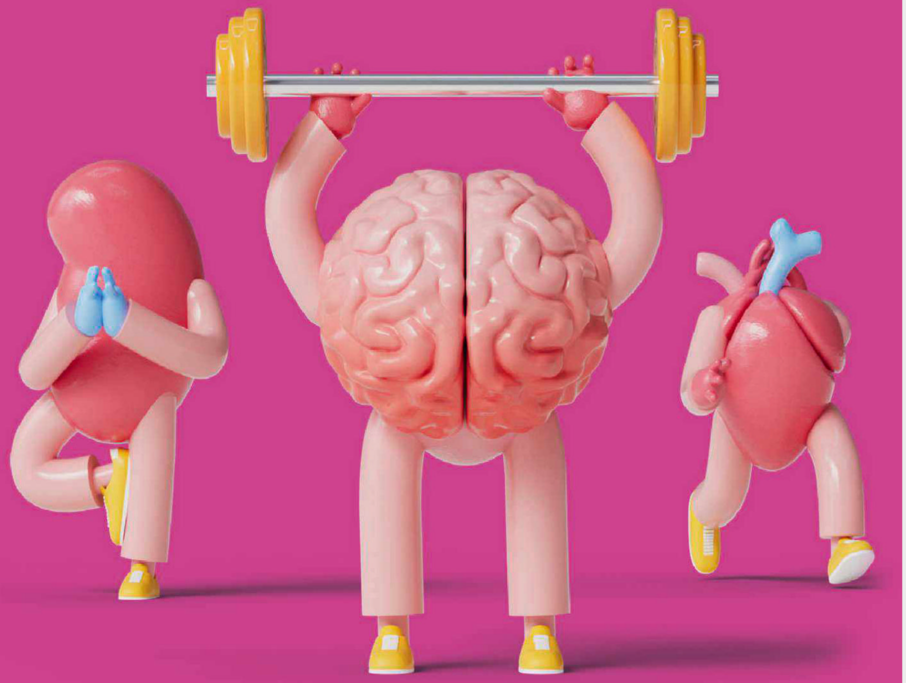
More recently, a 2023 study analysed 270 previous studies, covering over 15,000 people, to determine which exercises lowered blood pressure the most. While all types of exercise had a positive effect, isometric exercises were the most effective. These involve holding a static position (e.g. squatting against a wall) rather than moving continuously.

Other effective exercises included running, walking, cycling, weightlifting and high-intensity workouts.

The research also found that for noticeable blood pressure reductions, exercise sessions should last between 20–40 minutes, three to five times per week, over at least four weeks. This reinforces that consistency is key.

While medication still remains crucial for many, these findings highlight how powerful lifestyle changes can be. Exercise, along with a healthy diet and stress management, can not only help control blood pressure but also reduce reliance on medications such as beta-blockers.

The evidence is clear. If you want to take charge of your blood pressure, regular, moderate-intensity exercise is a great place to start. But it's just one piece of the puzzle. Reducing salt intake, maintaining a balanced diet and managing stress all play crucial roles. And for some, blood pressure medication remains an important part of treatment. The good news? Exercise can also complement these strategies. ***NM***



DARCIE WALSH, PRESTON

COULD SCIENTISTS UPLOAD AN ANIMAL BRAIN TO A COMPUTER?

The answer to this depends on what you mean by 'upload' and 'brain'. If you're a little free and easy on both, then it's been done already.

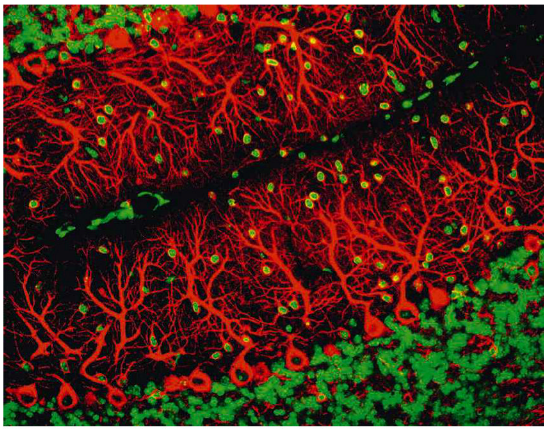
Caenorhabditis elegans is a tiny little worm that lives in soil and rotting vegetation. It's a multicellular eukaryotic organism, so it technically counts as an animal. This little worm never grows to more than 1mm (0.03in) long and is one of the best-known creatures on the planet.

We have sequenced its genome and mapped the development of every one of its 2,000 or so cells – including its 300 neurons. There's little variation in the worm, and what variation there is has been mapped as well. So, scientists have been able to model the entirety of its brain in a computer – which not only shows the same reflexive behaviours as the real thing, it can even be trained to do a couple of new tricks too, such as balancing a virtual pole (yes, really).

But if we become a little pickier about our definitions, then this doesn't quite cut it. The simulated *C. elegans* brain was not uploaded from a real one – it was copied from data gathered from years of experiments on thousands of worms. There wasn't a way to record the thoughts or memories of one individual creature and upload them correctly into a computer.

There are a lot of people who believe brain uploading is the future of the human race: an 'inevitable consequence' of our current research in neuroscience and artificial intelligence (AI), the ultimate way to cheat death. But there are some serious difficulties to overcome before that happens.

If our minds are entirely composed of and constructed by the physical cells and chemicals in our skulls and nervous system, we'll somehow have to read the state of the brain in perfect detail. Then we'll have to



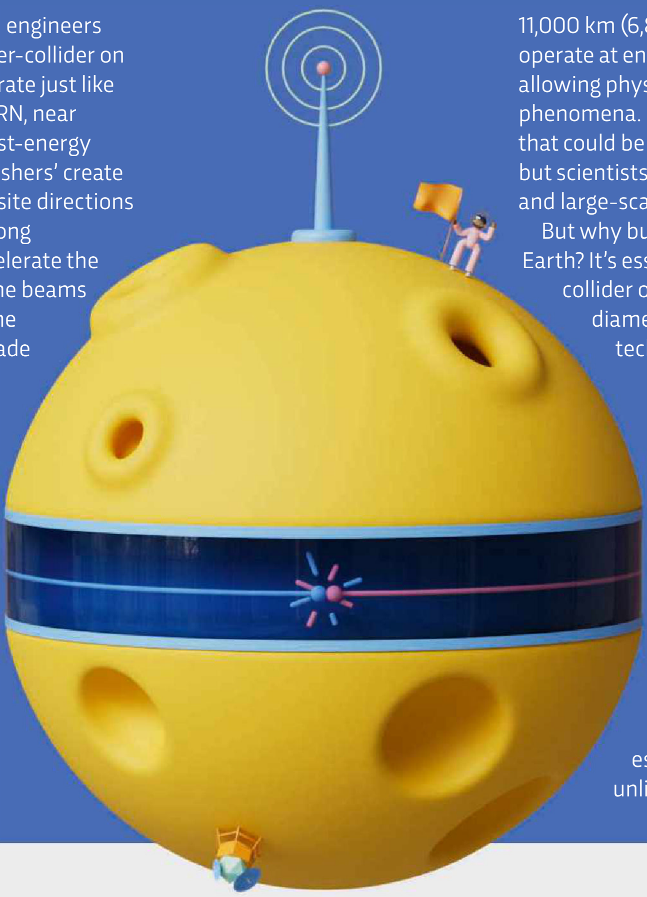
FAYE HOLMES, VIA EMAIL

WHAT IF WE BUILT A SUPER-COLLIDER AROUND THE MOON?

Somewhat surprisingly, scientists and engineers have indeed considered putting a super-collider on the Moon. Such a machine would operate just like the Large Hadron Collider (LHC), at CERN, near Geneva, the world's largest and highest-energy particle accelerator. These 'atom-smashers' create two particle beams travelling in opposite directions through ultra-high-vacuum rings. Strong superconducting electromagnets accelerate the beams to almost the speed of light. The beams are then allowed to collide in one of the detector instruments, creating a cascade of other particles which are then measured and analysed.

The more energy your collider particles have, the higher the mass of the collision 'products'. Many of the questions in modern particle physics (and there are many) require exploration of this high-mass parameter space. So, physicists are keen to build bigger and more powerful colliders. And as it turns out, the Moon is an ideal spot.

One study, in 2022, considered an atom-smasher around the circumference of the Moon – almost 11,000 km (6,835 miles) in length. The collider would operate at energies 1,000 times greater than the LHC, allowing physicists to search for new particles and phenomena. It's difficult to predict the discoveries that could be made with such a colossal accelerator, but scientists hope it could shed light on the evolution and large-scale structure of the Universe.



But why build the machine on the Moon, and not on Earth? It's essentially a problem of real estate. A collider of more than 10,000 km (6,214 miles) in diameter presents many geological, technological and political challenges here. The Moon, on the other hand, would only offer advantages. It would be easier (and cheaper) to build a circular tunnel beneath the lunar surface, and to maintain the high-vacuum rings essential for the collider. The Moon is also more geologically stable than Earth, and has a plentiful supply of solar power.

Engineers think it would take more than two decades to build a super-collider on the Moon (once a continuous human presence has been established), so a lunar 'mega-collider' is unlikely to happen in this century. ***AG*** create a software model that reproduces the behaviour of the brain down to molecular, or probably atomic, accuracy.

More than a decade ago, scientists showed that it was possible to identify neurons and their connectivity in a carefully prepared piece of mouse brain. After careful staining, it was sliced into layers 70 nanometres thick, and a computer reconstructed the 3D form. Needless to say, the mouse didn't survive.

This is an example of destructive scanning – the method that many suggest will be necessary to record the brain in sufficient detail. A brain can't survive the scan.

Some argue that as medical scanners achieve higher and higher resolution, one day we may be able to scan the state of every cell without destroying them. But such a scan would have to be instantaneous, otherwise one part of the brain could already be thinking something new before the scan was fully complete.

> **"THERE ARE A LOT OF PEOPLE WHO BELIEVE BRAIN UPLOADING IS THE FUTURE OF THE HUMAN RACE"**

Could it be performed on a recently deceased brain? Scientists have suggested that we may need to scan the brain while it's actively working in order to ensure the modelled behaviours of every cell are correct.

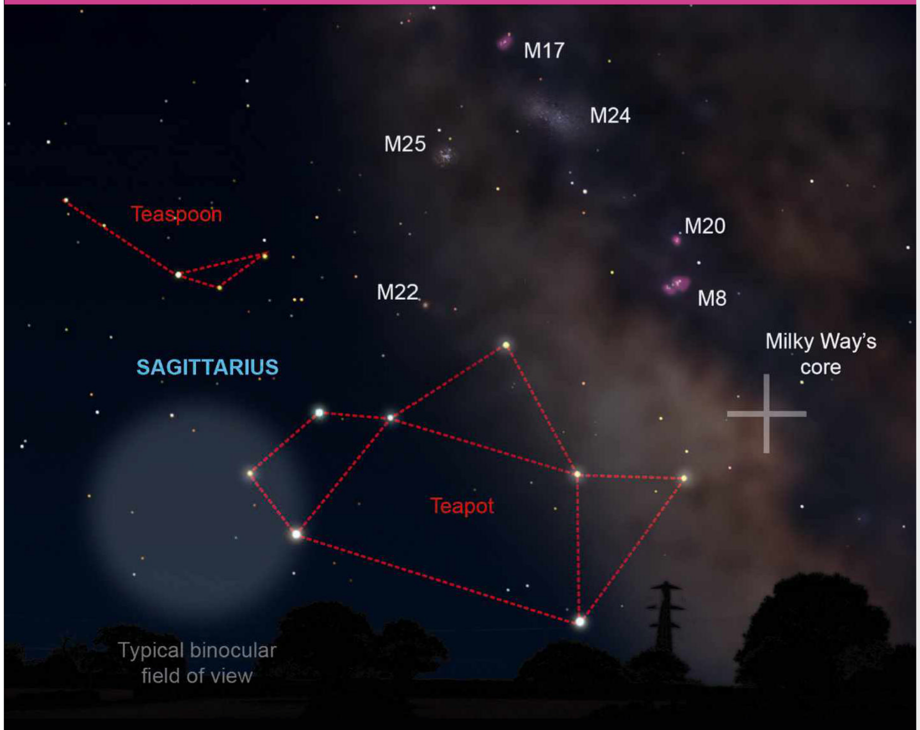
Today's computers are amazing, but even the most optimistic futurists still predict a wait of a hundred years or so before we could simulate the required atomic levels.

And then there's a final difficult question. If in 500 years it becomes possible to upload your brain non-destructively… in the instant after it happens, two yous would exist. A you existing in the virtual world of computer software. And the original you, still thinking with your wetware, perhaps with a slight headache after the scans.

But if you're still alive, did you really cheat death? Clearly not. Instead, you've made it possible for anyone to take virtual-you, make copies and use you for anything they want. Sounds terrifying. ***PB***

SCIENCE PHOTO LIBRARY, ALAMY, ILLUSTRATION: CRAIG BOYLAN, PETE LAWRENCE

ASTRONOMY FOR BEGINNERS



LOOKING TOWARDS THE SOUTH DURING THE LAST WEEK IN JULY AROUND MIDNIGHT BST AND LAST HALF OF AUGUST FROM 10PM BST

HOW TO SEE: A TEAPOT IN THE SKY

WHEN: JULY/AUGUST

The constellation of Sagittarius is not well presented from the UK. It's the most southerly Zodiacal constellation in the sky, the Zodiac representing 12 constellations the Sun passes through over the course of the year, even though the actual number is 13. Between 30 November and 17 December, the Sun lies within Ophiuchus, which isn't officially recognised as a Zodiacal constellation.

Sagittarius's low southerly aspect is unfortunate because its stars mark the way towards the core of our Milky Way Galaxy. From a dark sky reserve, this would look very spectacular – if it wasn't so close to the horizon. There are still delights to be seen here, however. Only half of Sagittarius rises above the horizon as seen from the UK, and it's within this half that you can find an unofficial pattern or 'asterism' known as the Teapot. This forms a fairly convincing pattern outlining a teapot in the sky.

If you can identify it, the core of the Milky Way sits just west (right) of the spout – the shape on the west (right) side of the pattern. This is the direction of the supermassive black hole Sagittarius A* (read as: 'A Star'), which lies at the centre of our galaxy. View from the darkest sky location possible, timing your view to avoid the Moon.

Look at the region just above the spout. From a dark location, the region appears interesting to the naked eye and comes alive through binoculars or a small telescope, revealing objects such as the Lagoon Nebula (M8), Trifid Nebula (M20), Swan Nebula (M17) and the rich Small Sagittarius Star Cloud (M24).

Using our chart as a guide, first try and identify the Teapot with the naked eye. Then use binoculars to pick out the pattern before heading north of the spout to see these treasures of the summer sky. ***PL***

by PETE LAWRENCE
(@Avertedvision)
Pete is an astronomy expert and presenter on The Sky at Night.

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TIM HATLEY, LINCOLN

WHAT'S THE BEST POSITION TO SLEEP IN?

There are plenty of claims about the "best" sleep position – for example, it's often thought that sleeping on your left side aids digestion. This idea comes from basic anatomy: the stomach sits to the left, and its outlet (the pylorus) tilts slightly to the right, connecting to the small intestine.

There's some evidence that left-side sleeping may reduce acid reflux compared to the right, as it positions the stomach in a way that makes acid less likely to creep up into the oesophagus. If you suffer from reflux or heartburn, it certainly could be worth trying.

But digestion happens regardless of how you sleep. So, unless you have a specific digestive issue (like reflux), your position likely won't make much difference.

Of course, sleep is about more than digestion. Back sleeping (supine) is often recommended to reduce pressure on the neck and lower back. However, it can worsen snoring or sleep apnoea by allowing the tongue to flop backwards, partially blocking the airway.

Side sleeping is the most common and can also help with snoring and sleep apnoea by keeping airways more open. Pregnant women are often advised to sleep on their left side to improve blood flow to the baby and reduce pressure on the liver, but right-side sleeping is generally fine too.

If you have back or pelvic pain (especially if pregnant), side sleeping with a pillow between your knees, can also ease pressure on the lower back.

So, what's really the best position to sleep in? Ultimately, there's no single optimal sleep position. Left-side sleeping might be helpful for reflux or pregnancy, but for most people, the priority should be comfort, spinal support and good-quality sleep – whichever position you can get that in.

And let's be honest, no matter how carefully you position yourself at bedtime, you'll probably wake up drooling into your pillow in some completely different pose anyway! ***NM***

YVONNE TEVLIN, VIA EMAIL

HOW CAN I BEAT COMPASSION FATIGUE?

The idea of 'compassion fatigue' was first proposed in the context of nurses who spend their working days caring for people, showing them compassion and empathy – and sometimes witnessing them going through traumatic experiences.

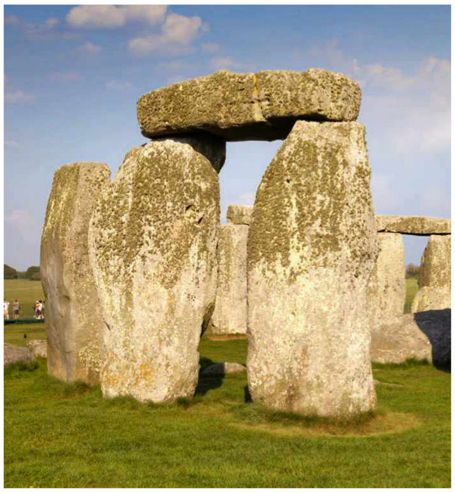
There are really two parts to compassion fatigue. There's the emotional exhaustion and sometimes there's also the secondary trauma, from watching someone else suffer.

Of course, it's not just nurses who can be at risk. It could affect anyone in a caring or related profession who is required to engage emotionally with others and/or watch them deal with difficult experiences. Even outside of a formal work role, you could be at risk if you spend a lot of your time showing up emotionally for someone else and/or seeing them suffer.

Research with nurses has revealed that compassion fatigue can manifest in at least two main ways. First, as a kind of emotional numbing (think of it like a defence mechanism that kicks in to prevent you from becoming completely emotionally drained).

JOHN MACPHERSON, RIPON

ARE THERE ANY OTHER STONEHENGES?



Stone circles are the stuff of ancient rituals and druid mythology. While many of us are most familiar with the stone circle at Stonehenge near Amesbury, England, which dates back to about 2500 BC (4,525 years ago), there are numerous examples of 'menhirs' (standing stones) and ancient stone arrangements worldwide.

Some of these stone monuments are even older than Stonehenge. Northern Japan's Ōyu Stone Circles, discovered in 1931, for instance, date back some 3,500 years, while there are Aboriginal stone circles dotted across Australia, some of which have been estimated to be nearer to 10,000 years old.

Stone monuments are rarer in America, however. Which is why, in 2007, archaeologists got excited when they discovered what appeared to be a human-made arrangement of stones at the bottom of Lake Michigan. One of the archaeologists, Mark Holley, has been trying to raise funds to excavate the site ever since, protecting it from disturbance by withholding its exact location.

At this point, it's not clear how the stones got there. One possibility is that the line marks a 'driving lane' for caribou hunting, like a better-studied, 9,000-year-old stone arrangement in Lake Huron, which would have been dry when the lane was marked out.

Lake Michigan was dry until about 15,000 years ago. By some estimations, then, the stones could have been in place for much longer than those in Lake Huron, and Stonehenge. ***HB***

GETTY IMAGES, MARK HOLLEY, NASA ILLUSTRATION: CRAIG BOYLAN

QUESTION OF THE MONTH

DERRYCK MORTON, VIA EMAIL

CAN LIQUIDS EXIST IN SPACE?

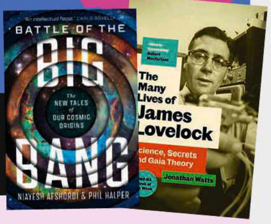
The liquid state of matter requires a relatively narrow range of temperature and pressure to exist. Put simply, as pressure is lowered, the boiling and freezing (or melting) points of matter begin to converge. In space, where the pressure is essentially (but not quite) zero, these transition points are at about the same temperature.

This means a liquid cannot exist in the low-pressure environment of space. Any material will be either a solid or a gas, and this depends on the temperature of the environment. This is true for all materials, including mercury and other metals.

This doesn't mean that liquids don't exist elsewhere in the Universe. If there's pressure in a planetary atmosphere or beneath a planet's crust, there is the potential for liquids to form. ***AG***

WRITE IN

The writer of next issue's Question of the Month receives **two hardback popular science books**: *The Many Lives of James Lovelock* and *Battle of the Big Bang* **worth over £50!**


BATTLE OF THE BIG BANG
NIAYESH AFSHORDI & PHIL HALPER
The Many Lives of James Lovelock
Jonathan Watts

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Second, in physical symptoms, which can range from a stomach upset to fatigue and difficulty sleeping.

A 2022 paper interviewed nurses and some of their descriptions were particularly evocative. For instance, one of them described it as, "A different kind of fatigue; cloudy, deep, sweeping. Like being in a cloud, or tired from a hangover."

Another, referring to the emotional numbing, put it this way: "A bit like [being] a kind of foil-clad person, in some way it bounces… what is said does not reach me all the way… it bounces back somehow."

Unfortunately, studies on compassion fatigue show it can become self-perpetuating. The numbing effect can lead you to begin putting on a front – appearing to show care and empathy on the surface, while in reality, you aren't experiencing these emotions. This disconnected state is uncomfortable and stressful, exacerbating your feelings of exhaustion. It can lead you to question your own values (e.g. I want to be a caring person, so why aren't I feeling more concerned for this person?) leading you to question your very sense of self.

The good news is that there are now several studies, albeit of mixed quality, that point towards ways to cope with, and overcome, compassion fatigue. The main approach is to try to practise self-compassion.

Self-compassion involves making time to get some respite from caring for others. This could mean anything from setting aside time for walks in nature, mindfulness, exercise, reading, watching TV or making time to hang out with friends.

It sounds obvious, but it's not always easy to do when you're feeling emotionally drained. One trick is to imagine the advice about self-care you'd give to a friend who means a lot to you, and then apply that advice to yourself. ***CJ***

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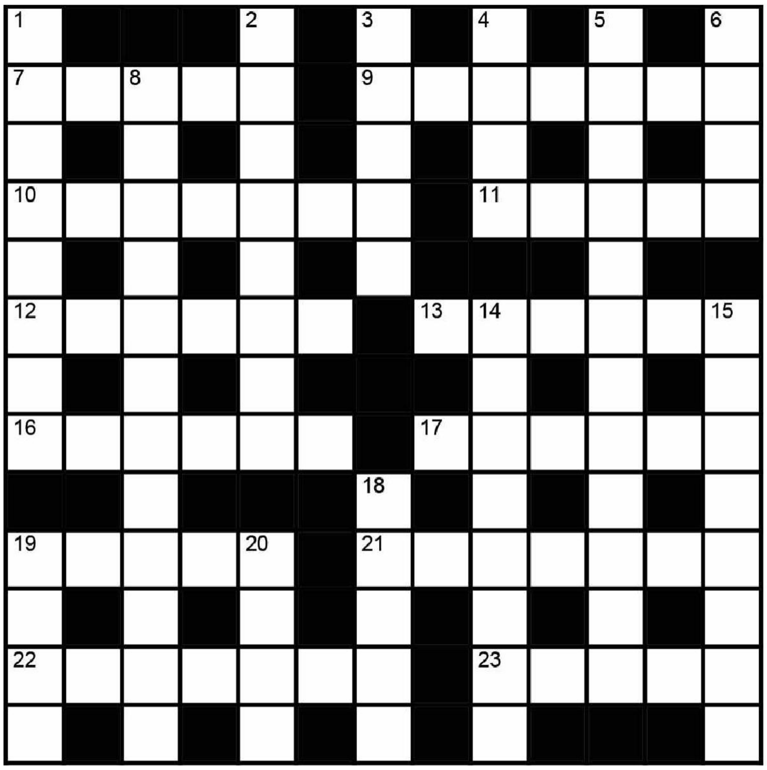


ACROSS

7 Morag groaning about stroppy behaviour (5)
9 Down-to-earth person alerts assembly around one (7)
10 Gold in smart move to get damages (7)
11 In France, you put sauce on Dutch export (5)
12 Get comfortable at home with the French (6)
13 Knock a self-service arrangement (6)
16 Embedded in botany? (6)
17 Answers about next deity (6)
19 Dot gets small kiss (5)
21 Unsettles starlet, sadly (7)
22 Lacklustre youngster went back to detectives (7)
23 The criminal in charge, showing set of morals (5)

DOWN

1 Fellow adjusted nearest clasp (8)
2 Upset mare with foul recipes (8)
3 Angry sign (5)
4 Wish of western soldier (4)
5 Doctor's invoice for sailing certificate (4,2,6)
6 Cancel socialists' initial summit (4)
8 Former PM with keys to container (9,3)
14 A French bird went ahead without a name (8)
15 Negotiate some land, bringing in a couple of Poles (8)
18 Churlish, initially, impolite and coarse (5)
19 Strongbox is unharmed (4)
20 Use one's foot for fun (4)

ANSWERS For the answers, visit **bit.ly/BBCFocusCW**
Please be aware the website address is case-sensitive.

GETTY IMAGES

NEXT ISSUE

IMPOSSIBLE PLANETS

The bizarre planets that defy expectations and challenge the cosmic rulebook

PLUS

HEARING CLUES

Better hearing, better thinking? Your ears could be the key to supporting brain health

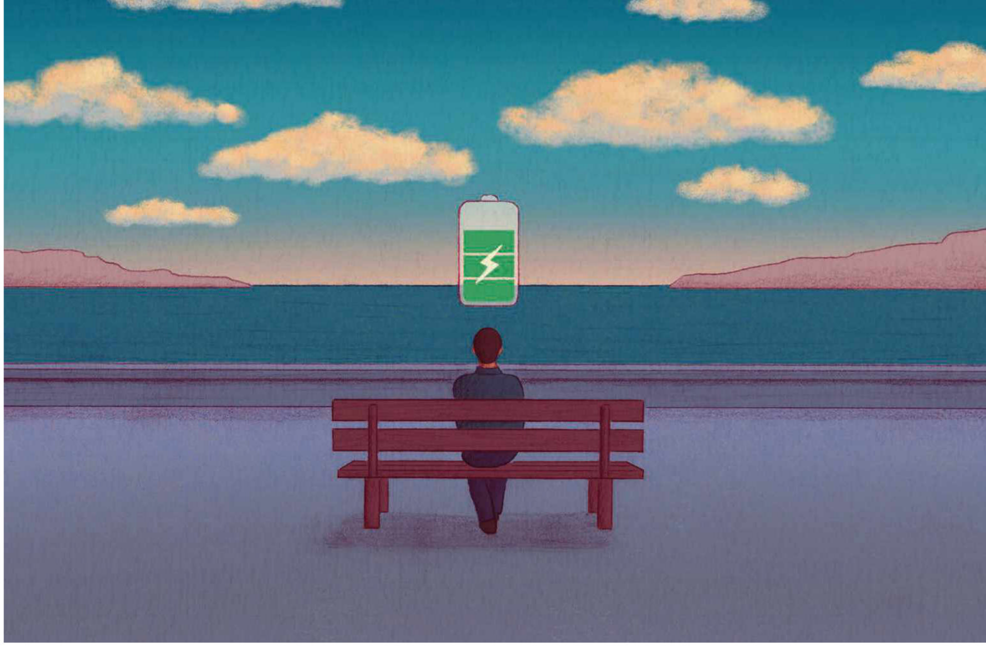
AGE-DEFYING MEALS

Subtle changes may trigger powerful anti-ageing processes in the body

ON SALE 29 JULY

SF

BETTER LIVING THROUGH SCIENCE



SOLITUDE SOLUTIONS

Shut the door, switch off your phone. Science says being alone is good for us

by **IAN TAYLOR**
Ian is a freelance science writer and the former deputy editor of BBC Science Focus.

Human beings are social animals. We evolved in groups and conquered the world in great big family units that we call civilisations. At a fundamental level, we need the company of other people.

So why is it that, every once in a while, I wish I had the planet to myself? I like to think of myself as a humanist, a pluralist, a generally nice chap. But sometimes – and it's not that infrequent to tell you the truth – I'd like the seething mass of humanity around me to just, sort of, be gone.

Of course, there are 8 billion of us, so I'm not – ahem – alone in this. The desire to be by yourself can be every bit as strong as our instinct to seek out friends and family. Researchers even have a name for it: aloneliness. The mirror image of loneliness, it describes the negative symptoms and emotions that arise when you don't get any real time to yourself.

Introverts like me understand it better than most, but we're not the only ones. Parents staring down the barrel of a six-week school holiday get prickly at this time of year. People who live in busy flatshares or work in people-infested environments like schools and hospitals know the feeling, too.

And funnily enough, the idea of solitude is of interest to a lot of people. Dr Thuy-Vy Nguyen is one of them. A psychology professor at Durham University, her research shows that having some alone time is important because it puts us in a kind of post-stress recovery mode.

"One thing that we consistently see in our research is that alone time is very good for emotion regulation," she says. "We did a study where we induced stress at the beginning [of the experiment]. Then we brought people to a room by themselves and in just a brief period of 15 to 30 minutes, you see the calming down of all these emotions and stress."

Interestingly, this dimmer switch on our emotions didn't work when participants were in the room with another person. Maybe it's because solitude is a time for rest and renewal.

Anger, anxiety and overexcitement all come with a certain amount of cognitive load, but it all seems to melt away when we get a moment to ourselves. Nguyen even finds there's a physical effect. "We look at cortisol as an indicator of stress, and that goes down in solitude," she says.

A sense of calm is not the only benefit. Research during the COVID-19 lockdowns found that time spent by yourself can increase your creativity. Other work has shown that alone time can improve a person's self-compassion and resilience.

All of it might sound surprising to those of us who've heard that loneliness is an epidemic – and a dangerous one, too. It's been linked with poor mental health and even an increased risk of cardiovascular disease and early death. But there's a big difference between solitude and isolation.

Loneliness is something you don't always have a choice about. Solitude is something you can seek out and even optimise.

The first way to do that is to introduce some structure to your alone time, Nguyen says. "Sometimes if it's empty time, that's when people start finding it challenging." Give yourself something to do.

In one of her experiments, Nguyen asked people to sort through hundreds of pencils, which they found preferable to sitting there doing nothing. Older research even found that people would rather administer mild electric shocks to themselves than just sit there.

Nguyen makes miniature models in her free time, which feels like a healthier option. As does reading, gardening, jigsaw puzzles or sketching. "Start with an activity that keeps your hands engaged," she says – but don't automatically reach for your phone.

Nguyen is investigating whether distracting devices could interfere with the cognitive processes that happen during solitude. "When we are alone, we have the opportunity to reflect and think about our days," she says. "The way that phones are designed kind of captures your attention and you start multitasking instead."

Another tip is to get out of the house, especially if it's a busy one.

"If you're constantly in a high-stress environment, when you're alone, you might not be able to detach from it," Nguyen says. "That's why a lot of parents feel they have to remove themselves from the house. There's a difference between alone time and personal time."

Speaking as a lonely parent limbering up for the hectic summer holidays ahead, I can tell you that's gospel. **SF**

> **"WE LOOK AT CORTISOL AS AN INDICATOR OF STRESS, AND THAT GOES DOWN IN SOLITUDE"**

ILLUSTRATION: ELIZABETH SANDUVETE CHAVES

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